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Abstract

This report describes the architecture, installation and configuration of the ACCENT policy system. It is seen that virtually all the ACCENT components are bundles deployed on an OSGi system. These bundles communicate using the OSGi event service. The details are given of how to set up and configure each of the bundles.

Keywords: ACCENT (Advanced Component Control Enhancing Network Technologies), APPEL policy language (ACCENT Project Policy Environment/Language), goal, OSGi (Open Systems Gateway initiative), policy.

Changes in Version 2

Relative to the version of April 2011:

- support for Plugwise energy monitors has been added in sections 2.12 and 3.4.18.

Changes in Version 3

Relative to the version of May 2011:

- barcode reader hardware is now introduced in section 2.1, the corresponding driver has been listed in section 3.4.2, and details have been given in section 3.4.6
- RFID reader hardware is now introduced in section 2.1, the corresponding driver has been listed in section 3.4.2, and details have been given in section 3.4.21
- an overview of Knopflerfish is now given in section 3.4.1, including an explanation of how to run Knopflerfish in the background as a Windows service
- the policy server parameters in section 3.4.18 have been slightly updated
- running the policy wizard in Tomcat is now described in section 3.4.20

Changes in Version 4

Relative to the version of September 2012:

- a description of the Raspberry Pi small computer that has been used to run Accent is now given in section 2.1
- use of Java and serial ports on the Raspberry Pi are now described in sections 3.1 and 3.2
- the position with regard to 32-bit and 64-bit operating systems is now discussed in section 3.1
- the audio and speech player is now mentioned in section 3.4.2, and details have been given in section 3.4.5
- observations about running the Ontology Server remotely have been added to section 3.4.16
- the location of Policy Wizard property files has changed as described in section 3.4.20

Changes in Version 5

Relative to the version of February 2013:

- section 3.4.1 explains that bundles are now configured by means of property files located according to the *uk.ac.stir.cs.accent* system property (they were previously placed in the Knopflerfish *osgi* top-level directory)
- the offline conflict analyser is now described in sections 3.4.2 and 3.4.8
- section 3.4.18 has been updated to reflect the current policy server properties (in particular, the server debug flags have changed slightly)
- in section 3.4.20, the *uk.ac.stir.cs.accent* property now determines whether the policy wizard is running as a bundle, and the policy wizard mapping file is now always internal

Changes in Version 6

Relative to the version of June 2013:

- the title of this report now qualifies its subject as home care
- the PolicyAction bundle has now been removed as IRTransDriver and X10Driver now directly perform *device_out* actions
- driver locations have now been mentioned in sections 2.2 and 2.3 for the ACR122U RFID reader and the Cipherlab 1070 barcode reader
- section 2.5 now describes the FitBit fitness monitor

- section 2.8 now describes the i-Buddy
- section 2.10 now describes the Nabaztag
- section 2.14 now describes Tunstall sensors
- section 2.15 now describes the TuxDroid
- section 3.1.2 now mentions the Java version 8 preview that works on the Raspberry Pi
- section 3.4.1 now mentions a Knopflerfish property to be set for unpacking bundle JARs
- section 3.4.2 now omits PolicyAction, with corresponding changes in start levels
- sections 3.4.2 now gives a number of new start levels for bundles
- sections 3.4.2 and 3.4.5 now mention that AudioPlayer starts at level 10
- sections 3.4.2 and 3.4.8 now describe the new ConfigurationSetup bundle
- section 3.4.5 now describes AudioPlayer changes for a new *audio.entity* property, speech synthesis to file, use of audio clips, and use of a preamble tone rather than a delay
- section 3.4.9 now defines an 'overwrite' parameter for the ConflictAnalyser bundle
- sections 3.4.2 and 3.4.10 describe the new FitBitDriver bundle
- sections 3.4.2 and 3.4.13 describe the new ForecastService bundle
- section 3.4.2 and 3.4.14 describe the new IBuddyDriver bundle
- section 3.4.15 now defines actions parameters for IRTransDriver, while section 3.4.29 now defines actions parameters for X10Driver
- sections 3.4.2 and 3.4.16 describe the new NabaztagDriver bundle
- section 3.4.17 now describes how ontologies can be served from the local host, and introduces a new property *rmi.path* for cases where guidance needs to be given on finding *rmiregistry*
- section 3.4.18 now defines the properties *variable.prefix* and *server.records* for the policy server, *server.log.lines* has been renamed *server.lines*, and a new 0400 debug flag has been added
- section 3.4.20 now defines the properties *policy.message.port*, *system.prefix*, *wizard.debug*, *device.actions* and *device.triggers* for the policy wizard
- section 3.4.25 describes the new SpeechRecogniser bundle
- sections 3.4.2 and 3.4.26 describe the new TunstallDriver bundle
- sections 3.4.2 and 3.4.28 describe the new TuxDroidDriver bundle

Changes in Version 7

Relative to the version of April 2014:

- section 3.4.13 describes the revised location parameter for ForecastService
- section 3.4.25 explains that SpeechRecogniser now conforms to the Google Speech API Version 2 and therefore requires a developer key parameter

Changes in Version 8

Relative to the version of July 2015:

- the overall framework now uses Knopflerfish 5.2.0, with consequent changes in some bundles
- section 3.1.1 no longer references *Jacspcsc.dll* and mentions that RFIDDriver will now work on 32-bit and 64-bit Windows
- FitBitDriver in section 3.4.10 has been updated for the latest FitBit API using OAuth 2.0; as a result, a number of properties have changed
- section 3.4.21 no longer references *Jacspcsc.dll* as the new RFIDDriver implementation uses the Java SmartCardIO API; the polling interval parameter is no longer used

Changes in Version 9

Relative to the version of January 2017:

- the overall framework now uses Knopflerfish 8.0.9, with consequent changes in some bundles
- testing has now been carried out on Microsoft Windows 10 and Raspberry Pi 4
- section 2.1 mentions use with the Raspberry Pi 4
- section 2.2 now explains how to use smartcard readers on the Raspberry Pi
- section 2.5 introduces new support for the EasyBulb and similar lights
- section 2.3 introduces new support for the Amazon Echo
- section 2.7 comments on the availability of drivers for the Eston GPRS609
- section 2.10 clarifies compatibility of the Nabaztag with WiFi
- section 2.15 mentions additional sources of libraries for the TuxDroid

- sections 3.2 now uses NRJavaSerial for interfacing to serial ports
- section 3.4.2 discusses getting hold of Xerces-J and Pax Web, and provides updated start levels for a variety of bundles
- section 3.4.4 discusses the new AccentSchemas bundle
- section 3.4.5 clarifies the formats of audio and clip messages for AudioPlayer, the new ability to play WAV files using the recipient *player*, and notes the new start level as 11
- section 3.4.7 mentions NRJavaSerial for all CommAccess serial port communication, with the property *serial.ports* instead of *comm.ports*
- section 3.4.8 gives an extended list for ConfigurationSetup with all the bundles whose inputs and outputs are collected; which file is updated is also now more explicit
- section 3.4.10 discusses the new EasyBulbDriver bundle
- section 3.4.11 discusses the new EchoBridge bundle
- section 3.4.12 gives examples of FitBitDriver inputs and gives more explicit advice about getting a FitBit access token
- section 3.4.15 clarifies the types of actions supported by IRTrans devices; channel and track numbers can now be one to three digits
- section 3.4.16 mentions that, for NabaztagDriver, use of *belly* and *center* lights has been removed, that the *off* action has been removed, and that the *on* action has been renamed as *show*
- section 3.4.17 mentions use by OntologyServer of the new AccentSchemas bundle
- section 3.4.18 clarifies the types of actions and inputs supported by Plugwise devices; an example is now given of simulating output to a Plugwise device
- section 3.4.19 introduces a new PolicyServer property *mail.user* for the email account user, and notes that only SMTP with plain authentication is supported
- section 3.4.20 uses the PolicyWizard property *users.port* for the database host port and *users.database* for the database containing the users table (in place of *users.table*); it is now mentioned that the audio clip applet is unlikely to work in recent browsers; the values for ontology URLs have been clarified; use of older Pax Web bundles with Java id discussed
- section 3.4.21 gives examples of tags that might be produced by RFIDDriver
- section 3.4.22 clarifies the use of sensor ids by RFXCOMDriver for Oregon Scientific devices
- section 3.4.25 mentions that Google Speech API keys may no longer be available
- section 3.4.26 clarifies how device inputs relate to the Tunstall properties
- section 3.4.28 clarifies the types of actions and inputs supported by a TuxDroid; examples are now given of TuxDroid inputs and outputs

Table of Contents

1 Introduction

This document describes the architecture, installation and configuration of the ACCENT policy system (Advanced Component Control Enhancing Network Technologies), mainly for its use in home care. The policy system is comprehensive and flexible, with a variety of components developed on the projects ACCENT (https://accentsuite.sourceforge.io), MATCH (http://www.cs.stir.ac.uk/~kjt/research/match) and PROSEN (http://www.cs.stir.ac.uk/~kjt/research/prosen). Among the major elements documented elsewhere are the APPEL policy language (ACCENT Project Policy Environment/Language [5]), the ACCENT Policy Server [2], the ACCENT Policy Wizard [4], and the ACCENT Ontology Server [1].

This report describes the major components of the policy system for home care, how to install them, and how to configure them. The policy system supports a substantial amount of hardware and software. The main hardware used is as follows:

- Amazon Echo
- Barcode readers
- EasyBulb lights and similar
- Eston GPRS609 GPRS modem
- FitBit fitness bands
- i-Buddy 'Internet buddy'
- IRTrans modules for infrared control (USB and Ethernet variants)
- Nabaztag 'Internet rabbit'
- RFXCOM USB receivers for Oregon Scientific and Visonic sensors
- Oregon scientific wireless environment sensors
- Plugwise energy monitors
- Tunstall telecare equipment
- TuxDroid 'Internet penguin'
- Visonic wireless home sensors
- X10 appliance control

The software versions below are those that have been used in testing, though later versions may be suitable:

- Firefox 74, Internet Explorer 11
- NRJavaSerial 3.15 and SerialPort 8.2
- JAVE 1.0.2
- jNabServer 2.1 (with modifications)
- JRE 8.N
- Knopflerfish 6.1.3 with Xerces-J Bundle 2.10.1
- Microsoft Windows 10
- MySQL 8.0.17 with MySQL Connector/J 5.1.48
- Pax Web Jetty Bundle 1.0.2, Pax Web JSP Support 1.0.2, Pax Web WAR Extender 0.8.0
- Raspbian 4.19
- TSpaces 2.1.2

2 Hardware

2.1 Raspberry Pi

The Raspberry Pi (https://www.raspberrypi.org) is a small computer that runs Linux. Both version 2 and version 4 have been used to run the ACCENT system.

The Raspberry Pi 2 (32-bit kernel and user space) has an ARM11 processor that runs at 700MHz, 256MB or 512MB memory, a 10/100Mbps Ethernet connection, two USB ports, an HDMI port, and other features. An SD/SDHC card is used as a solid-state disc. Although part of this is used as swap space, it is strongly preferable to have 512MB memory in order to reduce use of swapping. An Ethernet connection to the Internet is strongly desirable as the processor board does not have a real-time clock. The recommended operating system is Raspbian, an optimised version of Debian 'Wheezy'. This comes in two variants: 'armel' that uses soft floating point, and 'armhf' that uses hard floating point.

The Raspberry Pi 4 (64-bit kernel and 32-bit user space) has a Broadcom BCM2711 processor that runs at 1.5GHz, 1/2/4Gb memory, a Gigabit Ethernet connection, four USB ports, an HDMI port, WiFi, Bluetooth and other features. A micro SD/SDHC card is used as a solid-state disc. Although part of this is used as swap space, it is strongly preferable to have lots of memory in order to minimise use of swapping. An Ethernet connection to the Internet is strongly desirable as the processor board does not have a real-time clock. The recommended operating system is Raspbian, an optimised version of Debian 'Buster'.

In recent versions of Raspbian, access to devices is controlled by rules under */lib/udev/rules.d* and also under */etc/udev/rules.d*. USB devices that emulate a serial port are likely to be accessible only by root. This can be fixed by creating a file such as *60-usb.rules* in */etc/udev/rules.d* that places USB devices in group *staff* and makes them readable/writable by this group. The level of this rule (60) ensures that it is run after *50-udev-default.rules* in */lib/udev/rules.d*.

```
KERNEL=="ttyACM[0-9]*", GROUP="staff", MODE="0660"
KERNEL=="ttyUSB[0-9]*", GROUP="staff", MODE="0660"
```

On Linux (i.e. Raspberry Pi), serial devices are simply numbered. These numbers may also not be persistent across reboots. It is therefore necessary to assign symbolic names to serial devices. This is done in the same USB rules file as above, making use of the vendor, product and (if available) serial number information. This can be obtained by running '*lsusb -v*'. Examples might be:

```
SUBSYSTEM=="tty", ATTRS{idVendor}=="0745", ATTRS{idProduct}=="0001",
 SYMLINK+="ttyBarcode"
SUBSYSTEM=="tty", ATTRS{idVendor}=="0403", ATTRS{idProduct}=="6001",
 ATTRS{serial}=="A2003F0c", SYMLINK+="ttyPlugwise"
SUBSYSTEM=="tty", ATTRS{idVendor}=="067b", ATTRS{idProduct}=="2303",
 SYMLINK+="ttyX10"
```

2.2 ACS RFID Reader

The ACS (Advanced Card Systems) ACR122U has been tested with ACCENT. This requires a driver and JNI (Java Native Interface) code. The driver can be downloaded from:

```
https://www.acs.com.hk/en/products/3/acr122u-usb-nfc-reader
```

The reader works on Microsoft Windows without any special installation. On a Raspberry Pi, it is first necessary to install *libnfc-bin* and *pcscd*. The latter runs PC/SC (Personal Computer/Smart Card) as a daemon. Java may need help in locating the *pcsclite* library, so place the following into the Knopflerfish file *osgi/restart.xargs* or *osgi/fwdir-accent/fwprops.xargs*:

```
-Dsun.security.smartcardio.library=/usr/lib/arm-linux-gnueabihf/libpcsclite.so.1
```

2.3 Amazon Echo

Amazon Echo devices (https://en.wikipedia.org/wiki/Amazon_Echo) are voice-controlled devices that connect externally to services in the cloud and locally to devices via Bluetooth or WiFi. In the context of ACCENT, the Echo is used for voice control of various output devices – those that support on, off, dim and hue (or similar commands). The code has been tested with an Amazon Echo Dot 3.

2.4 Cipherlab Barcode Reader

Many barcode readers emulate a keyboard so that barcodes appear as if typed. For use with the ACCENT system, a barcode reader needs to interface as a serial port. The Cipherlab 1070 can be set into VCOM (Virtual COM port) mode by scanning appropriate barcodes that are provided with the manual. Specifically, scan 'Enter Setup', 'Activate Direct USB VCOM_CDC' and 'Update'. The barcode reader will then appear as a COM/TTY port. The VCOM driver can be downloaded from:

```
 https://www.silabs.com/products/development-tools/software/usb-to-uart-bridge-vcp-
drivers
```

2.5 EasyBulb/LimitlessLED/MiLight Lights

EasyBulb (http://www.easybulb.com) make a range of LED lights that are network-controlled. LimitlessLED and MiLight appear to be equivalent brands. For use with the ACCENT system, interface code has been written for an EasyBulb Plus WiFi bridge that controls RGBW (Red-Green-Blue-White) LED lamps. (The code may work only with version 1 of the bridge).

Reset the EasyBulb bridge if necessary, then connect to the WiFi network created by the bridge. Login with the default username *admin* and password *admin*, then change these values immediately. Set the network name, username and password for the WiFi router that the bridge should connect to. After the bridge is restarted, it will get a local IP address by DHCP from the router.

The bridge expects to communicate using UDP (User Datagram Protocol). For reliability it should be set to use TCP (Transmission Control Protocol). To do this choose Other Setting then Network Parameters Setting, and set Protocol to TCP-Server. Save the settings and reboot the bridge.

2.6 FitBit Fitness Monitor

FitBit fitness monitors such as the Flex are typically equipped with an accelerometer, a (simple) display, input by tapping the monitor, and vibration output. These fitness monitors can be used to record lifestyle factors such as number of steps taken per day and sleep patterns. The device is connected through Bluetooth to the system running ACCENT. With FitBit Connect running, the presence of a FitBit monitor in the area is checked every 15 minutes. TThe FitBit Connect and FitBit Setup applications can be downloaded from a location such as:

```
 https://www.fitbit.com/uk/setup
```

2.7 GPRS Modem

Any GPRS modem can, in principle be used. However, the code has been tested with an Eston GPRS609 (using a BenQ M32 chip, https://www.portech.com.tw/data/BenQ%20M23%20AT.pdf) that has a USB interface. A 64-bit driver is not currently available.

By following https://sites.google.com/site/klaasdc/modify-pl2303-pid-vid it is possible to change the USB product identifier for this device so that it is recognised as a Prolific PL2303 device and uses the corresponding driver. *However*, it seems that the device then no longer responds to AT commands and so can no longer be used as a modem.

2.8 i-Buddy Internet Buddy

The i-Buddy 'angel' is an Internet Buddy developed by Union Creations to signal information from Windows Messenger. The i-Buddy connects via USB. It has three head LEDs that can be set for different colours, a red heart light that can be turned on and off, wings that can be made to flap, and the ability to rotate left or right. This program can be downloaded from:

```
    https://www.snellelinks.nl/images/ibuddy/ibuddy210-f07.exe
```

The i-Buddy can also be controlled from Java using JLibiBuddy that can be downloaded from:

```
    https://github.com/Boukefalos/jlibibuddy
```

This requires the Java HID API available from:

```
    https://code.google.com/archive/p/javahidapi
```

2.9 IRTrans Transmitter

An infra-red transmitter made by IRTrans (https://www.irtrans.de) is used to exchange infrared signals with domestic appliances such as TVs, CD players and DVD recorders.

2.9.1 IRTrans Server

On Windows, the server *IRServer.exe* or *IRTransTray.exe* can be run from the IRTrans installation directory. On the Raspberry Pi, *irserver* needs to be compiled from the Linux source code found at http://www.irtrans.de/en/download/linux.php. In either case a parameter of USB can be used to find a USB-connected device.

After reading the definitions of remote controls (in subdirectory *remotes*), the server listens on port 21000 on the local host. To accept commands from another host, the firewall may need to be modified to accept connections on port 21000.

The commands for a remote control are identified in a *.rem* file in the *Remotes* sub-directory of the installation directory. The names of these files are converted to lower case (e.g. *TV_Lounge.rem* becomes the remote control *tv_lounge*).

A *.rem* file has a format such as:

```
[REMOTE]
  [NAME]TV_Lounge

[TIMING]
  [0][N]2[1]512 2024[2]512 4552[RC]3[RP]40[FREQ]39

[COMMANDS]
  [Vol+][T]0[D]0011101010010
```

This gives the *NAME* of the remote control and its *TIMING*. These are followed by the commands for the remote control such as *Vol+*. A file like this is created using the *Learn* command of the server or of the GUI client. Choose a name for the remote. Then, in turn, enter a name for each command and click the *Learn* button. Point the remote control at the IRTrans LEDs and click the corresponding button on the remote control. The IRTrans will flash as it learns the command.

Some commands from a remote control toggle a bit in the signal. These can be accommodated by adding *[TOGGLE][4][01]* at the end of the timing.

2.9.2 IRTrans GUI Client

A GUI client *IRRemote.exe* is provided to communicate with the server, normally on the local host port 21000 and using TCP. This uses the file *Remote.irm* in the installation directory to display the layout of a remote control such as:

```
[TV]
[FRMPIX]230,220
[LBL]10,200     [SIZE]300,30[TEXT]TV[FONT]14
[SLED]1

[POS]10,10      [SIZE]110,30[TEXT]Power    [REMOTE]TV_Lounge   [COMMAND]Off
```

This defines a *TV* device section. *FRMPIX* gives the x,y extent of the remote control panel in a window. *LBL* defines one or more labels that appear in this window. *SLED* defines the use of LEDs (1 = internal).

Then each button is defined on a line of its own. A *POS* field gives the x,y position of a button, while *SIZE* defines its x,y extent. *TEXT* defines the button label. *REMOTE* identifies the file of IR commands for a remote control. *COMMAND* defines the command in this file associated with the button.

2.9.3 IRTrans Command-Line Client

Code in C is provided for a command-line client. Compile *irclient.c* as follows (possibly using *gcc*):

```
cc -o irclient -O irclient.c
strip irclient
```

The command-line client can now be called as:

```
irclient host_identifier remote_name command_name
```

e.g.:

```
irclient triton TV_Ferguson 3
irclient 10.0.0.18 TV_Ferguson Off
```

The remote name and command name can be in upper or lower case.

2.9.4 IRTrans UDP Communication

A UDP socket can be created to send commands to the IRTrans server. Send data in the format:

```
SND remote_name,command_name,Pport_number
```

e.g.:

```
SND TV_Ferguson,Off,P21001
```

and expect a response such as *OK* or *ERR*. *SND* and *P* can be all lower or all upper case. The port number is the one used for the response to the client (21000 by default). Note that the response is not made to the port used by the client to send the message.

2.10 Nabaztag Internet Rabbit

The Nabaztag ‘Internet rabbit’ (https://en.wikipedia.org/wiki/Nabaztag) was created by Violet. The Nabaztag Tag is the second-generation device. It connects using WiFi to a configured Internet address (originally a Violet server). However, it can also be set up to use other servers including a local one. For input the device has a microphone, RFID tag reader, and movable ears. For output the device has a loudspeaker, multiple coloured lights, and movable ears. Nabaztag version 2 has been tested.

To set up the Nabaztag, press and hold the head button while powering the rabbit on – the lights will turn blue. This creates a wireless network called *nabaztagNN*. Connect to this, and go to 192.168.0.1 in a web browser. Configure the network parameters, ideally using DHCP from the wireless router. The rabbit should be set to connect to the system that will run the server. For example, this might use *192.168.0.15:8181/vl* (the *vl* for manufacturer Violet being needed).

The Nabaztag appears to work only with WPA (WiFi Protected Access) using PSK (Pre-Shared Key) and encryption AES (Advanced Encryption Standard). This may require the wireless router or access point security to be set appropriately. Although there is replacement firmware at https://github.com/RedoXyde/nabgcc/releases to support WPA2, this is an early version and was not found to work with the available routers. Once the rabbit has been configured, it will connect to the selected server system. This needs to run a servlet web container that responds to requests for JSPs.

Rabbits are identified by serial number, which corresponds to their wireless MAC address. jNabServer (as used by the Nabaztag Driver) supports a configuration server that allows rabbits to be given a friendly name. Typically connect to the jNabServer configuration server using *telnet* to port 6969.

2.11 Oregon Scientific Wireless Sensor

Wireless sensors made by Oregon Scientific (http://global.oregonscientific.com) are used to measure environmental variables such as temperature and humidity. The BTHR918 sensor measures indoor temperature, humidity and atmospheric pressure. The THGR228 sensor measures indoor or outdoor temperature and humidity. The THGR918 sensor measures outdoor temperature and humidity

2.12 Plugwise Energy Monitors

Modules from Plugwise (https://www.plugwise.com) are used to monitor electricity usage. These modules (‘circles’) are connected in a ZigBee network to a USB receiver (‘stick’) plugged into a computer. One module (‘circle+’) is designated as the network controller, e.g. it is responsible for the clock. The receiver uses an FTDI USB interface chip, with drivers available from:

```
https://www.ftdichip.com/Drivers/VCP.htm
```

Plugwise provide software (‘Source’) for configuring and controlling the network, and for reading electricity usage from the modules. It is not clear if it is strictly necessary to initially configure the network using the software, but it is probably wise to do so. Updates to module firmware are managed via this software.

2.13 RFXCOM Wireless Receiver

A wireless receiver made by RFXCOM (http://www.rfxcom.com) is used to read signals from Oregon Scientific and Visonic sensors. The receiver uses an FTDI FT2232R USB interface chip, with drivers available from:

```
https://www.ftdichip.com/Drivers/VCP.htm
```

When plugged in, the receiver appears as a COM/TTY serial port.

This receiver comes with a number of utilities on a mini CD. *RFReceiver.exe* on this can be used to view data from the port. By default the receiver works at 4800 bps. Before using the receiver with the policy system, it is necessary to set it for 38400 bps. Do this by running *RFReceiver.exe*, connecting a receiver, and clicking on ‘Toggle Baud Rate (don't use)’ to make it work at 38400 bps in future. The current setting can be checked by seeing if *RFReceiver.exe* can successfully decode a signal at the expected bit rate.

2.14 Tunstall Sensors

Tunstall (https://www.tunstall.co.uk) provide a wide range of sensors and actuators to support telecare and telehealth. Example sensors include the following models. When a sensor fires, its sensor identifier is sent as a two-digit ‘location’: a resident identifier (e.g. 01) or a room identifier (e.g. 41 for the kitchen). A two-character sensor code is also sent to indicate the kind of signal.

Model	Sensor Type	Battery	State	Code	Notes
41005/12-C0	bed/chair occupancy	4×AA	occupied	AZ	use port IP2 or IP3; use port IP4 and Palm emulator to program
			unoccupied	BA	
D4106009A	mattress pad				for use with bed/chair occupancy sensor
41005/25-A0			opened	AQ	

	universal sensor	Tadiran SL-360P	closed	AR	set DIP switches to 1110 0001 for door monitoring in this way
67005/60-A0	medication dispenser	2×AA	dose missed	CZ	signals if two hours late in taking medication
67005/89-A1	fast PIR	PP3	movement	BH	
67005/02-J1	pendant alarm		pressed	AA	
68005/01-A7	wrist alarm		pressed	AA	

Tunstall sensors connect wirelessly to a Lifeline Connect+ base unit. To register a sensor, hold the green button for five seconds to enter programming mode; the red button then flashes slowly. Then hold the green button for a further three seconds to enter registration mode; the red button then flashes quickly. At this point, activate the sensor to register it with the base unit. Finally, press the green button to return to normal operation.

The Lifeline Connect+ is programmed by using the PC Connect application supplied by Tunstall. The Lifeline Connect+ has been used on Microsoft Windows XP to 10 (32-bit and 64-bit). This can be downloaded from:

```
https://uk.tunstall.com/our-products/product-catalogue/lifeline-vi
```

PC Connect interfaces to the Lifeline Connect+ via a Tapit+. Depending on the model, this requires an RS232 or USB port on the PC. An RS232-USB converter may be required such as the FTDI UC232R. The 'User' model of the Tapit+ can be used for configuration and for receiving sensor data; the 'Schools Protection' model can also be used for sensor data. PC Connect allows locations to be assigned to wireless sensors (along with many other functions).

Some devices such as the bed/chair occupancy sensor or the property exit sensor are programmed using the Sensor Tool application for the Palm or Palm Emulator. A Palm Emulator and this application (version 1 or 2) can be obtained from Tunstall. The Palm Emulator requires a COM1 or COM2 serial port (or an RS232-USB converter to emulate this). The application (TIM icon) can be used to program the bed/chair occupancy pressure threshold (also set the ADLife option). When using version 1 of the application, press the Menu button and select Phase 2/Occupancy Sensor 151 or Phase 3/Occupancy Sensor 171, for example. When using version 2 of the application, select Cable and then OK.

2.15 TuxDroid

The TuxDroid 'Internet penguin' (https://en.wikipedia.org/wiki/Tux_Droid) was developed by Kysoh as a desktop companion. It connects wirelessly through a USB dongle that works with the TuxBox 2.0 application.

For input the TuxDroid supports head and wing clicks, light-level readings and audio recording. For output the TuxDroid supports movement of eyelids, beak and wings, turning eye lights on and off, rotation of the body (unless connected to a charger) and audio playback. The TuxDroid can be used by Java with the TuxDroid-Java package available from:

```
https:/github.com/Cicatrice/tuxdroid-java
```

The TuxDroid requires *libtuxdriver* which can be obtained for Windows from:

```
https://github.com/Cicatrice/tuxdroid-java
```

This includes libraries for Microsoft Windows XP to 10 (32-bit and 64-bit), where the DLL might be copied to *C:\Windows\System32*. On a Raspberry Pi it is necessary to build this library from the source at:

```
https://github.com/joelmatteotti/tuxdriver
```

and typically install it in */usr/lib*. The bundle also uses *jna.jar*, which can be found at:

```
https://github.com/java-native-access/jna
```

2.16 Visonic Wireless Sensors

Visonic make a variety of environmental and property sensors. Examples include the following models. In general, code 84 means normal, code 04 means alert, and code 0C means activated.

Model	**Sensor Type**	**Battery**	**State**	**Code**	**Notes**
MCT-211	wrist alarm	CR2025	pressed	0C	
MCT-241	pendant alarm	CR2	pressed	0C	
MCT-302T	magnetic contact	CR2	open	04	same transmitter as MCT-550
			closed	84	
MCT-425	smoke	PP3 Long Life	smoke	04	
			clear	84	
MCT-441	natural gas	CR123A	gas	04	mains-powered with 2-pin plug
			clear	84	

MCT-442	carbon monoxide	PP3 Long-Life	gas	04	
			clear	84	
MCT-550	flood	CR2	wet	04	same transmitter as MCT-302T
			dry	84	
NEXT PIR MCW	movement	CR123A	movement	0C	
			clear	8C	
CLIP T MCW	movement	CR123A	movement	0C	3 minutes before re-triggered

These transmitters send out a ‘supervisory’ signal every 15 minutes or so. This is actually two signals: the first contains a code indicating the current status of the sensor; the second contains the same code but has 800000 added to the address (e.g. DB11AE instead of 5B11AE). If the tamper alarm is set off by opening the device, 40 is added to the sensor code (e.g. C4 instead of 84).

2.17 X10 Modules

X10 devices are used to control appliances over the mains.

2.17.1 X10 Computer Modules

The DCIU computer module is made by Domia (http://www.domialifestyle.com). This is broadly equivalent to CM11U and CM12U modules from other manufacturers. This uses a Prolific PL2303USB interface chip, with drivers available from:

```
https://www.prolific.com.tw/eng/downloads.asp?ID=31
```

However, note that Prolific no longer support early versions of this chip (notably the HXA). It may therefore be necessary to obtain an archive version of a Microsoft Windows driver for this chip. When plugged in, the module appears as a ‘Prolific USB-to-Serial Comm Port’.

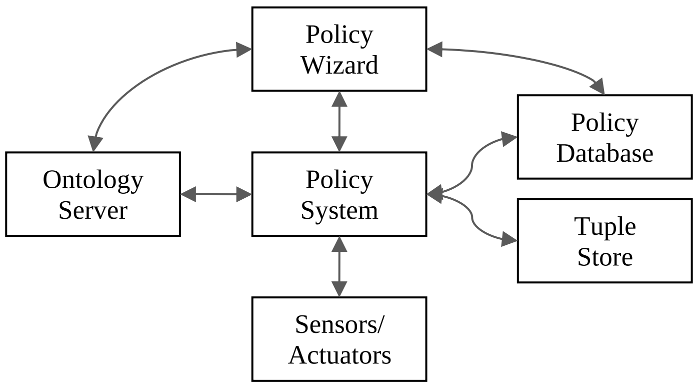
2.17.2 X10 Appliance Modules

These come from a variety of different manufacturers. Each module must be set to have a unique house address: house/room code (letters A to P) and unit/device code (numbers 1 to 16). Available modules include the following:

Model	**Function**
AD10	DIN rail switch (on, off, 16A)
AM12U	appliance module (on, off)
CM12U	computer module (RS232, USB)
LD11	DIN rail dimmer (on, off, dim, 700W)
LM12U	light module (on, off, dim)
SS13U	wall switch (3 × on, off, dim)
TM13U	transceiver module (on, off, dim?)

3 Software

A simplified architecture for the ACCENT policy system is given below:



For home care, input and output are supported by the driver bundles described below.

3.1 Java Run-Time Environment

3.1.1 Microsoft Windows

A JRE is required to run Knopflerfish (32-bit or 64-bit). This could be from Oracle:
`https://www.oracle.com/technetwork/java/javase/downloads`
or OpenJDK:
`https://openjdk.java.net`

As described in section 3.4.20 it is necessary to use an earlier Java version for compatibility with Pax Web. The libraries (DLL, SO) loaded by bundles need to match the operating system and JRE in terms of 32-bit or 64-bit version.

On Windows, serial ports are identified as *COM1*, *COM2*, etc. including USB devices that present a serial interface. The sample property files given in this report use Windows COM port numbers and Windows paths (with semicolon separators).

3.1.2 Raspberry Pi

A 32-bit JRE is required to run Knopflerfish; this could be from Oracle:
`https://www.oracle.com/technetwork/java/javase/downloads`
or OpenJDK:
`https://openjdk.java.net`

For the Raspberry Pi 2, Oracle JRE 8.*NN* has been used. For the Raspberry Pi 4, an OpenJDK JRE 11.*NN* is already included. However, as described in section 3.4.20 it is necessary to use an earlier Java version for compatibility with Pax Web.

On Linux, serial ports are identified as */dev/ttyNN*, etc. USB devices that present a serial interface are identified as */dev/ttyUSB0*, */dev/ttyUSB1*, etc. For the Raspberry Pi, names like *USB0* can be used for serial port numbers and Unix paths (with colon separators) should be used in property files. See section 2.1 for the preferable use of symbolic names for devices.

3.2 Java Serial Port Support

The original JavaComm driver does not work reliably on Windows 7 and above. Instead, SerialPort (https://www.serialio.com) can be used as a straight replacement. As appropriate, a 32-bit or 64-bit version of *jspWin.dll* can be placed into *C:\Windows\System32*. Note that a version of *jspWin.dll* will be needed that recognises normal serial ports as well as modem ports (e.g. for a GPRS modem). The files *jspComm.jar* and *Serialio.jar* can be placed into a Java extension directory or alternatively into the bundle.

NRJavaSerial (https://github.com/NeuronRobotics/nrjavaserial) has now been used for all bundles that access serial ports. This package is open-source, multi-platform and self-contained. Like SerialPort, NRJavaSerial can be used on both Microsoft Windows and the Raspberry Pi.

Serial port support is relevant for CommAccess and for many other bundles. The code is set up for use of the package *javax.comm*. To use NRJavaSerial in a bundle, change *import* statements in relevant source files to use *gnu.io* instead. After compiling the code, update the bundle manifest to import and export *gnu.io* instead of *javax.comm*.

3.3 Policy Database

The policy database is a standard relational database (MySQL). As this is not a bundle, it is installed and configured outside OSGi. For Microsoft Windows, MySQL can be installed from *https://dev.mysql.com/downloads/installer*. For Raspberry Pi, install *mariadb-server*. Login and privileges need to be set up for the *home_care* user. The *home_care* database needs to be set up with the users table. The latter defines *admin* and other users. Sample SQL scripts are provided in the 'lib' directory to automate this setup.

The policy database is supplemented by the TSpaces tuple-space server. Developed by IBM and made available under an evaluation licence, this no longer seems to be available online. See [2] for more detailed information about how the policy database is used.

3.4 OSGi Bundles

3.4.1 Knopflerfish Overview

For home care, ACCENT components are bundles deployed in the Knopflerfish implementation (https://www.knopflerfish.org) of OSGi (originally Open Services Gateway Initiative).

Knopflerfish is normally run with a GUI, e.g. by double-clicking on *framework.jar* in the *knopflerfish/osgi* directory. However, it is also possible to run Knopflerfish in the background. A Windows service can be installed with Windows *sc* or CygWin *cygrunsrv*. The following is an example of using the latter:

```
cygrunsrv -I Knopflerfish -p C:/usr/local/jdk/bin/java.exe
  -a "-jar C:/usr/local/knopflerfish/osgi/framework.jar"
  -c C:/usr/local/knopflerfish/osgi
```

This creates a log file in *C:/var/log/Knopflerfish.log*.

All bundles are configured by means of a property file (located in, say, C:/usr/local/Knopflerfish/accent). The location of these property files is defined by an entry in *init.xargs* and *restart.xargs,* or in *fwdir/fwprops.xargs*. In addition is necessary that bundles be unpackaged from their JARs (for NabaztagDriver and OntologyServer at least). The following properties must therefore be defined in the relevant *xargs* files:

```
uk.ac.stir.cs.accent=C:/usr/local/knopflerfish/accent
org.knopflerfish.framework.bundlestorage.file.always_unpack=true
```

Despite the lack of an associated terminal, Knopflerfish manages to start up and run as a service in the background. However, in the absence of a console it is not possible to manage the framework or to see Knopflerfish logs. The Telnet Console (which runs by default) can be used with:

```
telnet localhost 2323
```

and is configured with the following typical properties (in *init.xargs* and *restart.xargs,* or in *fwdir/fwprops.xargs*):

```
org.knopflerfish.consoletelnet.port=2323
org.knopflerfish.consoletelnet.user=admin-username
org.knopflerfish.consoletelnet.pwd=admin-password
```

This allows a remote user to manage the framework and to see logs. The HTTP Console (not installed by default, but available as *httpconsole* from the bundle repository) can also be installed. This is accessed in a web browser as follows, supplying the defined username and password:

```
http://localhost:8080/servlet/console
```

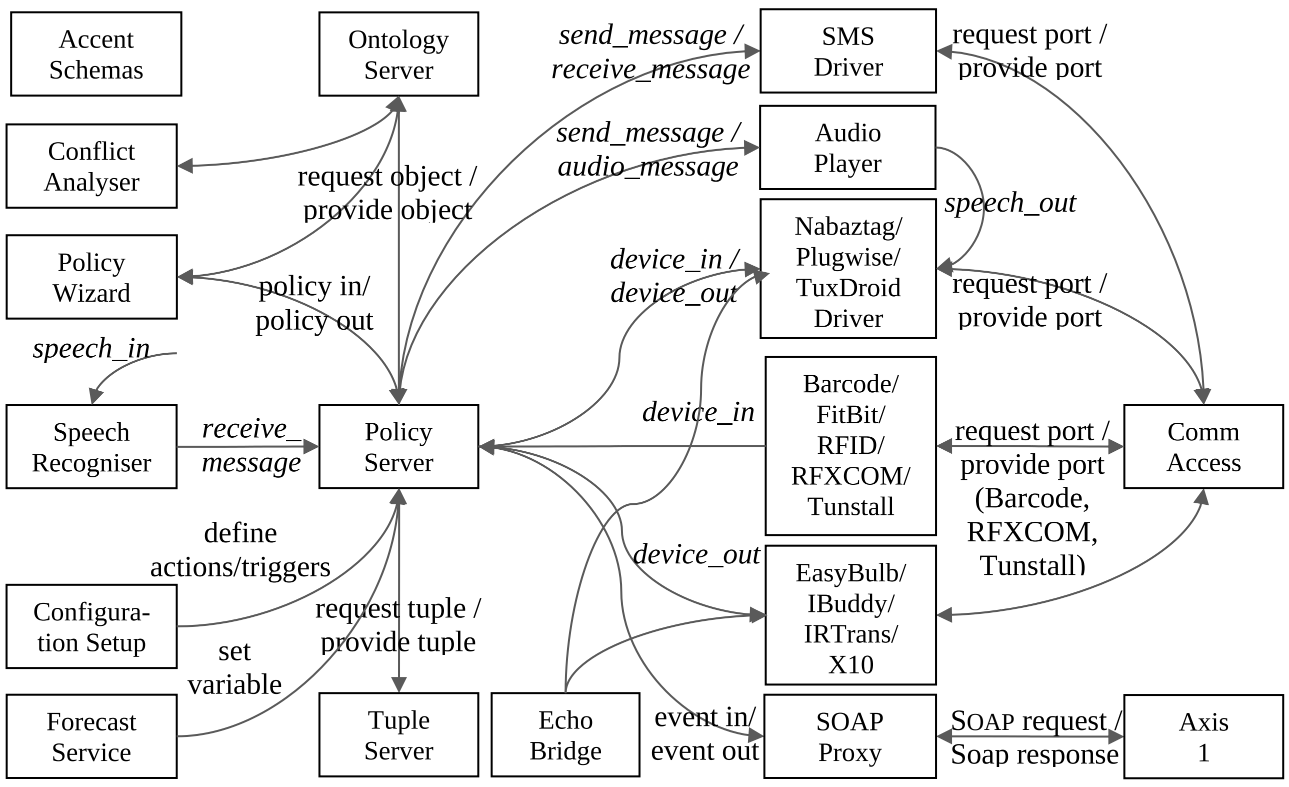
and is configured with the following typical properties in (in *init.xargs* and *restart.xargs,* or in *fwdir/fwprops.xargs*):

```
org.knopflerfish.httpconsole.requirelogin=true
org.knopflerfish.httpconsole.user=admin-user
org.knopflerfish.httpconsole.pwd=admin-password
```

This allows bundles (but not the framework or logs) to be manipulated.

3.4.2 Bundle Overview

The relationship among the ACCENT bundles is shown below. Names in italics are those of OSGi events.


Accent Schemas
Ontology Server
send_message / receive_message
SMS Driver
request port / provide port
Conflict Analyser
request object / provide object
send_message / audio_message
Audio Player
speech_out
Nabaztag/ Plugwise/ TuxDroid Driver
device_in / device_out
request port / provide port
Policy Wizard
policy in/ policy out
speech_in
Speech Recogniser
receive_ message
Policy Server
device_in
Barcode/ FitBit/ RFID/ RFXCOM/ Tunstall
request port / provide port (Barcode, RFXCOM, Tunstall)
Comm Access
define actions/triggers
device_out
EasyBulb/ IBuddy/ IRTrans/ X10
Configura- tion Setup
request tuple / provide tuple
set variable
Forecast Service
Tuple Server
Echo Bridge
event in/ event out
SOAP Proxy
SOAP request / Soap response
Axis 1

The bundles communicate via events, mediated by the OSGi Event Admin service. The bundles are mostly parameterised by Java property files located in the Knopflerfish directory (e.g. *knopflerfish/accent*). Depending on the Knopflerfish start level, it may be necessary to explicitly start bundles up to level 11. The start levels for ACCENT bundles are as follows:

Level	**Bundle**
6	Xerces-J
7	Axis1
7	CommAccess
7	ConfigurationSetup
7	EasyBulbDriver
7	FitBitDriver
7	IBuddyDriver
7	NabaztagDriver
7	Pax Web Jetty
7	Pax Web JSP
7	Pax Web WAR
7	SpeechRecogniser
7	TupleServer
7	TuxDroidDriver
8	AccentSchemas
8	BarcodeDriver
8	IRTransDriver
8	PlugwiseDriver
8	RFIDDriver
8	RFXCOMDriver
8	SMSDriver
8	SoapProxy
8	TunstallDriver
8	X10Driver
9	EchoBridge
9	OntologyServer

10	PolicyServer
11	AudioPlayer
11	ConflictAnalyser
11	ForecastService
11	PolicyWizard

The Xerces-J and Pax Web items in the table above are additional bundles needed for the Policy Wizard. Xerces-J is supplied through the Knopflerfish bundle repository, while Pax Web bundles/JARs are available from *https://ops4j1.jira.com/wiki/spaces/paxweb/pages/12059110/Download*.

3.4.3 Axis 1

The Axis bundle to support web services has been adapted from code by provided by Knopflerfish.

3.4.4 Accent Schemas

The AccentSchemas bundle can be used for local provision of the ACCENT XML schemas and ontologies, thus not requiring Internet access. The ontologies provided assume that Pax Web runs on port 8081, so a typical ontology will be found at *localhost:8081/schemas/home_care.owl*. If necessary, edit **only** the Owl imports (*owl:imports)* in the ontology files to have a different port number.

3.4.5 Audio Player

The AudioPlayer bundle plays pre-recorded audio files, pre-recorded speech files created using the policy wizard, and also performs TTS (Text To Speech). Audio is played by the policy action *send_message(recipient, message)*. The bundle uses the working directory *AudioPlayer* located in the ACCENT properties directory. This working directory is created automatically if needed, and is used for temporary synthesised speech files. It is possible to output pre-recorded audio clips and synthesised speech, either to the default audio device or to a specified one.

The policy server converts a *send_message* action with recipient *audio* or *audio:recipient* into an *audio_message* event without the '*audio:'* prefix that AudioPlayer listens for. If speech is to be synthesised into a file, AudioPlayer sends a *speech_out* event that provides the recipient (e.g. *nabaztag*) and the full path to the speech file. The intention is that another bundle for this recipient will output the speech file, which is then deleted to avoid temporary files building up.

If the recipient is *player*, the message value is taken to be the name of a WAV file to be played. This has been tested with all reasonable combinations of format: mono and stereo, 8/16/24/32 bits, and a sample rate from 8kHz to 44.1kHz.

If the recipient is an empty string or has value *default* then output is to the default audio device. Any other recipient value (besides *player*) causes an audio file (mono, 8-bit, 8kHz WAV file) to be created in the *AudioPlayer* directory. The name of this audio file has the format <*recipient*>< *time*>*.wav*, where *time* is the system time in milliseconds. For example, a TTS message to *nabaztag* might result in the file *AudioPlayer/nabaztag1390674487523.wav*. The creation of an audio file is notified by a *speech_out* event with *recipient* as the intended device (e.g. *nabaztag*) and *message* as the full path to the file (e.g. *C:/knopflerfish/accent/AudioPlayer/nabaztag1390674487523.wav*). The receiving bundle should output this audio file and then delete it.

If a TTS *message* has the form *!variable*, it is checked whether *text* names a policy variable. If so, its value is taken as a pre-recorded audio clip (mono, 16-bit, 8kHz WAV file). Otherwise *message* is treated as text to be synthesised using TTS. Such a message can start with *!voice* to indicate a voice other than the default specified in the properties file. (In this case, *voice* cannot be the name of a policy variable.) The message can contain speech markup such as '|', '||' or '|||' for a short, medium or long pause. An example message would be *'!Heather, Welcome back. || The house temperature is :interior_temperature.'*.

The property file *AudioPlayer.properties* defines the audio configuration. For TTS the bundle requires an installation of the Cerevoice Text-to-Speech SDK (https://www.cereproc.com/products/sdk). If this is not available, only pre-recorded clips can be played back. In such a case, only the *preamble.tone* property should be defined. An example property file is as follows (audio device *Speakers* for Windows, *ALSA* for Raspberry Pi):

```
# The owning entity for audio clip variables (user@domain):

audio.entity       admin@cs.stir.ac.uk

# The audio device used for playing sounds files (default no file playing):

audio.device       Speakers (3- Realtek(R) Audio)
# audio.device            ALSA [default]
# The licence file for Cerevoice (default no TTS):

licence.file       C:/usr/local/cerevoicej/licence.lic

# The directory for the dynamic libraries to support Cerevoice (default no TTS):

library.directory        C:/usr/local/cerevoicej

# The directory for Cerevoice voice files (default no TTS):

voice.directory          C:/usr/local/cerevoicej

#
# The default voice when not specified in the request (Heather - default,
# otherwise Jack, Sarah or Stuart):

voice.default            Sarah

# Some wireless speaker systems go to sleep when not receiving audio and can
# take a few seconds to wake up when audio is played back. If the name of a
# preamble tone is given, this is played first (current choices bell, cuckoo,
# sleigh, 20khz). If the property is not defined then there is no preamble.

preamble.tone            cuckoo
```

A request from the policy server to output a play an audio file can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send…* button. Set something like following, then click the *Send* button:

```
Event Topic        uk/ac/stir/cs/accent/audio_message
recipient          player
message            C:/sounds/warning.wav
```

A request to output a synthesised speech message from the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send…* button. Set something like following, then click the *Send* button:

```
Event Topic        uk/ac/stir/cs/accent/audio_message
recipient          default
message            !Sarah, welcome home. || Had a good day?
```

Speech file output from AudioPlayer can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send…* button. Set something like following then click the *Se* button, but note that the given audio file *will be deleted*:

```
Event Topic        uk/ac/stir/cs/accent/speech_out
recipient          nabaztag
message            C:/knopflerfish/accent/AudioPlayer/nabaztag1390674487523.wav
```

3.4.6 Barcode Driver

As described in section 2.3, a barcode reader like the Cipherlab 1070 needs to set to use a COM port. The property file *BarcodeDriver.properties* defines the driver configuration. This allows zero or more barcodes to be mapped to the corresponding item descriptions. This is useful for locally produced barcodes (e.g. to indicate a particular programme to be recorded or an appointment to be kept). It is also useful for short-form barcodes used by supermarket own-brand goods, when the normal UPC (Universal Product Code) may not be used. If a barcode is not found in the properties file, it is looked up online. Most online barcode services are commercial. BarcodeDriver is designed to work with the free *www.updcatabase.org*. This requires registration to obtain a developer key that is used in queries to the site. If the barcode is not known to the site, BarcodeDriver will provide the literal barcode (which may still be useful in a policy). However, it is possible for anyone to define new barcodes on the site.

Barcode readings result in input events of the form *device_in(reading,barcode,instance,,description)*. The instance is normally *single* for a barcode reading. However, BarcodeDriver allows the same barcode to be scanned twice (or more) in quick succession. In this case, the instance is *multiple*. This is intended for situations like bringing items into the house (a single scan) and disposing of them after use (repeated scans). This allows stocks of items to be maintained. The period within which multiple scans are recognised is defined in the properties file.

An example property file *BarcodeDriver.properties* is as follows:

```
# The port should be the serial port where the barcode reader can be found
# (appears in Windows Device Manager under Ports as "Silicon Labs CP210x USB
# to UART Bridge"):

barcode.portCOM6

# The owning entity on whose behalf events will be triggered (user@domain):

barcode.entity     admin@cs.stir.ac.uk

# The URL used to check barcodes (default "http://www.upcdatabase.org/api/json")

barcode.url http://www.upcdatabase.org/api/json

# The API key suffixed to the URL to identify the developer

barcode.key ----------------

# The period within which repeated scans of a barcode are allowed (seconds,
# default 2)

barcode.period     2

# The mapping translates each barcode into a string reported when the barcode is
# read. If a barcode is not found here, it is checked with www.upcdatabase.org.
# If it is not found there, the literal barcode is reported. The format of
# entries is:
#
#   key:    barcode
#   value:  item description (escape special characters, e.g. "\'")

25133707    Aldi Sweet Harvest sweetcorn
25211276    Bramwell's Real Mayonnaise
25213355    Stonemill Table Salt
25114515    Lacura Baby Lotion
20214029    Crusti Croc Cheese and Onion Crisps
25235043    Grandessa Smooth Peanut Butter
27013120    Wickes 40W R50 SES Light Bulbs
```

Input from a barcode to the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send*... button. Set something like following, then click the *Send* button.

```
Event Topic        uk/ac/stir/cs/accent/device_in
user               admin@house.stir.net
arg1               reading (message type)
arg2               barcode (entity name)
arg3               single or multiple (entity instance)
arg5               description or numerical identifier (parameter values)
```

3.4.7 Comm Access

The CommAccess bundle is adapted from code by Michael Wilson. It now makes use of NRJavaSerial. It opens the serial ports defined by the property file *CommAccess.properties*, e.g.:

```
# Comma-separated list of ports to offer via services (the actual ports
# may be a subset of this list). On Windows, ports have names like "COM3". On
# Linux (i.e. Raspberry Pi), ports have names like "ACM1" and "USB2"; these
# names are implicitly prefixed by "/dev/tty". Spaces around commas are ignored:
#
# Current usage is COM3 (RFXCOM), COM4 (X10), COM5 (Plugwise),
# COM6 (Barcode), COM7 (Tunstall), COM8 (SMS)

serial.portsCOM3, COM4, COM5, COM6, COM7, COM8, COM9, COM10
```

On a Raspberry Pi, the port list might look like:

```
serial.portsBarcode, Plugwise, RFXCOM, SMS, Tunstall, X10
```

The actual serial ports opened from the list will depend on what devices are actually available. CommAccess provides access to ports via an OSGi service.

3.4.8 Configuration Setup

The ConfigurationSetup bundle reads the property files of all relevant bundles (BarcodeDriver, EasyBulbDriver, FitBitDriver, IBuddyDriver, IRTransDriver, NabaztagDriver, PlugwiseDriver, RFIDDriver, RFXCOMDriver, TunstallDriver, TuxDroidDriver, X10Driver). It then updates the relevant PolicyWizard property file with lists of corresponding device actions and triggers. For example, for the home care domain it updates device actions and triggers in the file *PolicyWizard.home_care.database.properties* that is held where other bundle property files are stored. This is file is accessed by the policy wizard on bundle startup. If the policy wizard is instead run as a Tomcat web application, it would be necessary to manually update *PolicyWizard//WEB-INF/lib/home_care/database.properties* for example. After updating the properties file the bundle stops. It could therefore be set to run on every Knopflerfish startup.

The bundle is configured by the property file *ConfigurationSetup.properties*:

```
# Policy domain to be configured

policy.domain            home_care
```

This utility is normally run as a bundle, but could also be run as an application. In the latter case, certain constants in the code may need to be adjusted (the location of property files and the policy domain).

3.4.9 Conflict Analyser

The ConflictAnalyser bundle is an offline conflict analyser developed from code by Gavin Campbell. It will also run as a Java application. The conflict analyser is configured by the file *ConflictAnalyser.properties*, e.g.:

```
# Name of the policy server host (e.g. "localhost")

policy.host        localhost

# Port used for for uploading policies (e.g. 9999)

policy.port        9999

# Resolution policy owner

policy.owner       admin@cs.stir.ac.uk

# Name of the ontology server host (e.g. "localhost")

poppet.host        localhost

# Whether to overwrite an existing resolution ("true" or default "false")

overwrite.resolution     true
```

3.4.10 EasyBulb Driver

The EasyBulbDriver interfaces to EasyBulb colour and white lights via an EasyBulb Plus bridge (version 1). It appears that similar lights are also branded as LimitlessLED and MiLight.

The driver handles a range of colours and achromatic greys that are approximately those supported by an Amazon Echo:

```
Alice Blue, Antique White, Black, Blanched Almond, Blue Violet, Blue, Cadet
Blue, Chartreuse, Chocolate, Coral, Cornflower, Cornsilk, Crimson, Cyan, Dark
Blue, Dark Cyan, Dark Goldenrod, Dark Green, Dark Khaki, Dark Magenta, Dark
Olive Green, Dark Orange, Dark Orchid, Dark Red, Dark Salmon, Dark Sea Green,
Dark Slate Blue, Dark Turquoise, Dark Violet, Davy's Gray, Davy's Grey, Deep
Pink, Deep Sky Blue, Dim Gray, Dim Grey, Dodger Blue, Firebrick, Floral White,
Forest Green, Fuchsia, Gainsboro, Ghost White, Gold, Goldenrod, Gray, Green,
Green Yellow, Grey, Honeydew, Hot Pink, Indigo, Ivory, Jet, Khaki, Lavender,
Lavender Blush, Lawn Green, Lemon Chiffon, Light Blue, Light Coral, Light Cyan,
Light Goldenrod, Light Gray, Light Green, Light Grey, Light Pink, Light Salmon,
Light Sea Green, Light Sky Blue, Light Steel Blue, Light Yellow, Lime, Lime
Green, Linen, Magenta, Maroon, Medium Blue, Medium Gray, Medium Grey, Medium
Orchid, Medium Purple, Medium Sea Green, Medium Spring Green, Medium Turquoise,
Medium Violet Red, Midnight Blue, Mint Cream, Misty Rose, Moccasin, Navy Blue,
Old Lace, Olive, Olive Drab, Orange, Oraange Red, Orchid, Pale Goldenrod, Pale
```

```
Green, Pale Turquoise, Pale Violet Red, Papaya Whip, Peach  Puff, Peru, Pink,
Plum, Powder Blue, Purple, Rebecca Purple, Red, Rosy Brown, Royal Blue, Salmon,
Sea Green, Seashell, Sienna, Silver, Sky Blue, Slate Blue, Snow, Spanish Gray,
Spanish Grey, Spring Green, Steel Blue, Tan, Teal, Thistle, Tomato, Turquoise,
Violet, Web Green, Web Maroon, Web Purple, Wheat, White, White Smoke, Yellow
```

EasyBulb lights do not have individual addresses. Rather, they are addressed in four groups numbered 1 to 4, with group 0 meaning all lights. All EasyBulb lights support *on*, *off* and *dim* actions (the latter with a dim percentage parameter). Coloured lights also support *hue* actions (with a hue value from 0 to 360 degrees or a colour name as above). Achromatic greys are simulated by setting the light to white at some dim level.

The bundle is configured by the property file *EasyBulbDriver.properties*:

```
# The EasyBulb bridge name/address is as follows (default is automatic discovery
# of the first EasyBulb bridge found on the local network):

# bridge.host             192.168.1.2

# The following mapping describes a comma-separated list of mappings from
# policy actions to protocol commands. The key data must match policies in
# respect of case, but the value data can be in either case. Spaces can be used
# after commands, and special characters such as "=" must be escaped as "\=".
#
#   key:    message,entity,instance,parameters
#   value:  command,address,parameters
#
# One or more messages or commands may be given, separated by "|"; the number of
# these in the key and value must be the same. The instance is optional. The
# parameters can be comma-separated and are optional; if a policy action does
# not match the mapping with its specific parameters, a match is tried without
# the parameters.
#
# Parameters then instance may be omitted from the right (e.g.
# "message,entity,instance" and "message,entity" or "command,address" can be
# used).
#
# Mapping entries can be repeated for the same message, entity and instance but
# with different parameters.

# Anglepoise lamp in lounge

off|on|dim|hue,anglepoise,living_room  off|on|dim|hue,1

# Wall lights in bedroom

off|on|dim|hue,wall_lights,bedroom     off|on|dim|hue,2
```

Output to an EasyBulb light from the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send*... button. Set something like following, then click the *Send* button:

```
Event Topic       uk/ac/stir/cs/accent/device_out
arg1              hue (message type)
arg2              anglepoise (entity name)
arg3              living-room (entity instance)
arg5              purple (parameter values)
```

3.4.11 Echo Bridge

The EchoBridge bundle emulates output devices as Philips Hue/Lux lights where possible. This allows Amazon Echo voice commands to be issued to control ACCENT devices. This is for output only (input sensors are not supported) and for devices that support *on*, *off*, *dim* and *hue* commands (or similar).

EchoBridge uses an adaptation of the Hue Emulator https://steveyo.github.io/Hue-Emulator. The emulator should normally run on localhost port 80. If this is not possible (e.g. because another web server is using this or because of Linux restrictions on opening port 80), it is possible to run the emulator on a different port. However, it would then be necessary to reverse-proxy the URL patterns "/description.xml" and "/api/*" from port 80 to the given bridge port. This is possible with, for example, the Apache web server (e.g. see https://httpd.apache.org/docs/2.4/howto/reverse_proxy.html).

For advice about a non-root user opening port 80 on Linux (i.e. a Raspberry Pi), see *https://superuser.com/questions/710253/allow-non-root-process-to-bind-to-port-80-and-443*. Basically, install *authbind* then do:

```
touch /etc/authbind/byport/80
chmod 777 /etc/authbind/byport/80
```

In the startup script for Knopflerfish, execute Java as '*authbind --deep java -jar framework.jar ...'*

Policy wizard device actions for home care (defined in *PolicyWizard.home_care.database.properties*) are used to identify Echo devices. It follows that the ConfigurationSetup bundle must have been already run to set these actions up for the policy wizard. Echo device names are formed from the ACCENT names "*entity_name entity_instance*". The entity name and instance should normally be strings without spaces, though underscores can be used. If spaces or underscores are present in the ACCENT strings, these are automatically converted to hyphens in the Echo names.

ACCENT devices with message type *off/open*, *close/on/shut* or *channel_set/dim/set/track_set* are mapped to Echo 'light' devices with *on*, *off* or *set* commands respectively. For example Accent *off,tv,lounge* is mapped to Echo "*off,Tv Lounge"*, and ACCENT *open,tuxdroid,beak* corresponds to Echo "*off,Tuxdroid Beak"*.

When an Echo voice command is issued for a registered device, this is picked up by the EchoBridge bundle. The Echo command and device name are mapped to the corresponding ACCENT message type, entity name and entity instance.

In the case of a *hue* command, an Echo hue value (0..65535) is supplied for conversion to hue degrees (0..360). If the ACCENT device does not support *hue*, the command is ignored. Normally, an ACCENT *device_out* event is then sent to cause the corresponding action to be performed.

In the case of a *set* command, an Echo brightness value (0..255) is supplied for conversion to a dim percentage (0..100). If the ACCENT device does not support *dim/set*, the command is ignored. Normally, an Accent *device_out* event is then sent to cause the corresponding action to be performed.

Example Echo voice commands are:

- Discover devices
- Turn on the lounge light
- Switch the Anglepoise on
- Power on the wall lights
- Turn the living-room light off
- Switch off the TV
- Dim the bedroom light to 40 *[percent]*
- Set the standard light to peach *[a colour name]*
- Set the TV to 101 *[a channel number]*

The bundle is configured by the property file *EchoBridge.properties*:

```
# Port on which the bridge server runs (default 80). If the default port is
# unavailable, e.g. because another web server is in use, that web server needs
# to be set to reverse-proxy "/description.xml" and "/api/*" from port 80 to the
# given bridge port. On Linux, which requires root to open port 80, consider
# using "auth_bind" or similar.

# bridge.port      80

# The owning entity on whose behalf events will be triggered (user@domain):

bridge.entity      admin@cs.stir.ac.uk
```

3.4.12 FitBit Driver

The FitBitDriver bundle retrieves fitness information (steps, sleep) for a FitBit fitness monitor. Unlike most other bundles, FitBitDriver requires an Internet connection. FitBitDriver is configured by the file *FitBitDriver.properties*, e.g.:

```
# The owning entity on whose behalf events will be triggered (user@domain):

fitbit.entity             admin@cs.stir.ac.uk

# Interval between FitBit data retrieval (hours, default 3)

fitbit.interval           3
```

```
# Access token allocated by FitBit for retrieving data. If this value is not
# given, the bundle will output instructions on how to get an access token.

access.token       ------------------------------------------------------

# Client identifier allocated by FitBit for this application, used only when
# instructions are needed about how to get an access token

client.id                ------

# At intervals, the bundle will provide device inputs with arguments such as:
#
#   reading,fitbit,battery,,0   if battery low
#   reading,fitbit,sleep,,7.6   7.6 hours of sleep last night
#   reading,fitbit,steps,, 987  987 steps so far today
```

The client identifier is obtained after signing into *https://dev.fitbit.com/build/reference/web-api* and registering the bundle as an application. Then run the bundle with the *access.token* property set to empty. This will provide instructions on how to authorise access to a user's data, one year being the maximum period permitted.

3.4.13 Forecast Service

The ForecastService bundle uses UK-oriented forecasting services for air pollution (DEFRA, https://uk-air.defra.gov.uk), pollen level (MeteoVista, https://www.meteovista.co.uk), and weather forecast (OpenWeatherMap https://www.openweathermap.org). The last of these requires an API key to be obtained by signing up with the site.

Unlike most other bundles, ForecastService requires an Internet connection. It retrieves forecasts and stores them as text in the *exterior_pollution*, *exterior_pollen* and *weather_forecast* policy system variables. The value of these variables can then be used for, say, advising users to close windows or to give them a forecast. The bundle is configured by the property file *ForecastService.properties*, e.g.:

```
# The owning entity on whose behalf forecasts are stored (user@domain):

forecast.entity          admin@cs.stir.ac.uk

# Interval between forecast checks (hours, default 3)

forecast.interval        3

# Pollen forecast location (according to https://www.meteovista.co.uk, e.g.
# "Stirling/4409327")

pollen.location          Stirling/4409327

# Pollution forecast location (according to https://uk-air.defra.gov.uk, e.g.
# "56.12,-3.94" for Stirling, meaning 56.12 degrees North and 3.94 degrees West)

pollution.location       56.12,-3.94

# Weather forecast location (according to https://www.openweathermap.org,
# "<city>,<country>" e.g. "Stirling,UK", or location identifier e.g. "2636910")

weather.location         Stirling,UK

# Weather forecast user identifier (if required by the weather service)

weather.id               --------------------------------
```

3.4.14 i-Buddy Driver

The IBuddyDriver bundle interfaces to an i-Buddy 'Internet buddy'. It is configured by the property file *IBuddyDriver.properties*, e.g.:

```
  # In the following, alternatives are separated by '|'. Internal action
  # parameters are the same as policy parameters.
```

```
# Reinitialise everything on the i-Buddy

reset                                                     reset

# Flash the i-Buddy head a pair of colours for a fixed time

flash,head,blue+white|cyan+white|green+white|purple+white|red+white|yellow+white
  flash,head

# Set the i-Buddy heart off, on or to flash

flash|off|on,heart                                        flash|off|on,heart

# Set the i-Buddy head off or on for a fixed time

off|on,head,blue|cyan|green|purple|red|yellow|white      off|on,head

# Set or flap the wings

set,wings,down|up|flap_fast|flap_slow                     set,wings

# Spin operations that can be performed

rotate,body,left|right|spin                               rotate,body
```

3.4.15 IRTrans Driver

The IRTransDriver bundle supports infrared communication with domestic appliances such as air conditioners, CD players, DVD players and TVs. Note that an IRTrans server instance must already be running on the target host (whether local or remote), and that this must have definitions (*remotes* directory) compatible with the defined protocol commands. The bundle uses a remote IRTrans server defined by the property file *IRTransDriver.properties*, e.g.:

```
# The IRTrans server must already be running before the ITRTrans Driver is used.
# Start the server outside the OSGi framework (e.g. as a Start menu item). The
# server host name and port number for the system running the IRTrans server are
# as follows:

ir.server.name            localhost
ir.server.port            21000

# Port number for the system running the IRTrans client:

ir.client.port            21001

# The following mapping describes a comma-separated list of mappings from
# policy actions to protocol commands. The key data must match policies in
# respect of case, and the value data must similarly match what is in the
# IRTrans ".rem" (remote) files. Spaces can be used after commands, and special
# characters such as "=" must be escaped as "\=".
#
#   key:    message,entity,instance,parameters
#   value:  command,address,parameters
#
# One or more messages or commands may be given, separated by "|"; the number of
# these in the key and value must be the same. The instance is optional. The
# parameters can be comma-separated and are optional; if a policy action does
# not match the mapping with its specific parameters, a match is tried without
# the parameters.
#
# Parameters then instance may be omitted from the right (e.g.
# "message,entity,instance" and "message,entity" or "command,address" can be
# used).
#
# Mapping entries can be repeated for the same message, entity and instance but
# with different parameters.

# The following entries correspond to those in the IRTrans remotes directory
# ("C:\ProgramData\IRTrans\remotes" on Windows). Certain device commands are
# hard-coded and may be followed by "!":
#
#   off, on:        These are hard-coded to power a device off or on. If
#                   "on" is followed by "!" then the device is first powered
#                   on by sending the hard-coded device command "1" for
#                   channel/track 1. In all cases, the hard-coded device
#                   command "power" is sent to the device. No parameters are
#                   allowed for these commands. The power state of a device
#                   is noted so that these commands are sent appropriately.
#
#  channel, track: These are hard-coded for channel and track changes. A
#                   one- to three-digit channel or track number is then
#                   provided as parameter. If these commands are followed by
#                   "!" then a two-digit channel/track number must be
#                   provided as a parameter. In this case the hard-coded
#                   "nn" device command is sent first, followed by commands
#                   for each of the two digits.
#
#  other commands: Examples might be back/forward, channel-/+, drive, mute,
#                   next/previous, play/record/pause/stop, and volume-/+. No
#                   parameters are allowed for these commands.
#
# All devices are presumed to support "channel" or "track", "nn", "power" and
# "0" to "9" commands, corresponding to "channel" or "track", "off", "on" and
# "0" to "9" in the policy language.  Specialised policy commands are follows:
#
#   Panasonic DVD: back (slow), channel_down, channel_up, down (cursor
#   (recorder)           down), drive (select HDD, disc, etc. with down/up/ok),
#                   forward (slow), next (chapter), ok (cursor OK), pause,
#                   play, previous (chapter), record, stop, up (cursor up)
#
#   Sony TV:        channel_down, channel_set, channel_swap, channel_up,
#                   mute, volume_down, volume_up

# Panasonic DVD recorder in lounge
#   o channels 10 to 999 need digits in quick succession

off|on,dvd,lounge                      off|on,panasonic_dvd

0|1|2|3|4|5|6|7|8|9,dvd,lounge         0|1|2|3|4|5|6|7|8|9,panasonic_dvd

channel_down|channel_up,dvd,lounge     channel-|channel+,panasonic_dvd

channel_set,dvd,lounge                 channel,panasonic_dvd

back|forward|next|previous,dvd,lounge  back|forward|next|previous,panasonic_dvd

play|pause|record|stop,dvd,lounge      play|pause|record|stop,panasonic_dvd

down|drive|ok|up,dvd,lounge            down|drive|ok|up,panasonic_dvd

# Sony TV in lounge
#  o channels 10 to 999 need digits in quick succession

off|on,tv,lounge                       off|on!,sony_tv

0|1|2|3|4|5|6|7|8|9,tv,lounge          0|1|2|3|4|5|6|7|8|9,sony_tv

channel_down|channel_up,tv,lounge      channel-|channel+,sony_tv

channel_set|channel_swap,tv,lounge     channel|swap,sony_tv

mute|volume_down|volume_up,tv,lounge   mute|volume-|volume+,sony_tv
```

Output to an IR device from the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send...* button. Set something like following, then click the *Send* button:

```
Event Topic        uk/ac/stir/cs/accent/device_out
```

```
arg1              pause (message type)
arg2              CD (entity name)
arg3              lounge (entity instance)
```

3.4.16 Nabaztag Driver

The NabaztagDriver bundle bidirectionally interacts with a Nabaztag 'Internet rabbit'. Besides being a bundle, it can also be run as a Java application (using *jNabServer.jar*). The bundle interacts with a modified version of jNabServer for managing the Nabaztag (https://code.google.com/p/jnabserver). This effectively replaces the original Violet server with something roughly equivalent.

The system that runs the server dictates the IP address to be used by the Nabaztag. jNabServer can use a variety of ports, but it is best to avoid common ones such as 80 or 8080. The choice of port may also be affected by the local firewall.

For use with ACCENT, a Nabaztag is automatically associated with *AccentPlugin* when it first contacts the server. This plugin interacts bidirectionally with the bundle, allowing policy triggers to be provided and policy actions to be performed.

The bundle uses the working directory *NabaztagDriver* located in the ACCENT properties directory. This working directory is created automatically if needed. The directory is used to hold plugins (as defined by the bundle build – currently only *AccentPlugin*) and Nabaztag boot code (both copied from the bundle contents). It is also used for temporary audio input files that are created on audio input. The *save* command of the jNabServer configuration server preserves the state of a Nabaztag in *bunnies/<serialno>.ser*.

A *choreographies* sub-directory is created and used to temporarily store a 'choreography' *Accent.chor* as a series of commands created by the bundle. The Nabaztag reads these choreographies only periodically, so there can be a delay of some seconds before commands are executed. Although changes to ear state are permanent, changes to LED state apply only during the choreography. It follows that the changes to an LED do not persist: they can be only flashed or shown for a period. Another action will not be executed until this period has elapsed.

The bundle is configured by the property file *NabaztagDriver.properties*, e.g.:

```
# The owning entity on whose behalf events will be triggered (user@domain):

nabaztag.entity                 admin@cs.stir.ac.uk

# Port number for the jNab configuration server

nabaztag.configuration.port     6969

# Port number for the jNab rabbit server

nabaztag.rabbit.port            8181

# Debug setting ("debug", "error", "info" (default))

nabaztag.log.level              info

### Input triggers ###

# The following definitions give the device input message type,entity type and
# (if relevant) parameter values. The entity name is implicitly "nabaztag" in
# all cases. For example, moving the left ear down will result in the event
# "device_in(moved,nabaztag,left_ear,,down)".

# Button click on head

click,head                                    click,head
double_click,head                             double_click,head

# Ear position

moved,left_ear,back|down|forward|out|up       moved,left_ear
moved,right_ear,back|down|forward|out|up      moved,right_ear

# RFID tag (reported as a "reading" event)

D0021A053B4702E7                              weather report
D0021A053B45307B                              medicine
D0021A053B452E48                              how to cook
```

```
### Output actions ###

# The following definitions give the device output message type,entity type and
# (if relevant) parameter values. The entity name is implicitly "nabaztag" in
# all cases. For example, to move both ears forward requires the event
# "device_out(move,nabaztag,both_ears,,forward)".

# Lights (flash or show light for 10 seconds)

flash|show,bottom,blue|green|orange|purple|red|white|yellow \
  flash|show,bottom
flash|show,centre,blue|green|orange|purple|red|white|yellow \
  flash|show,centre
flash|show,left,blue|green|orange|purple|red|white|yellow \
  flash|show,left
flash|show,nose,blue|green|orange|purple|red|white|yellow \
  flash|show,nose
flash|show,right,blue|green|orange|purple|red|white|yellow \
  flash|show,right

# Ears

move,left_ear,back|down|forward|out|up move,left_ear
move,right_ear,back|down|forward|out|up      move,right_ear
move,both_ears,back|down|forward|out|up      move,both_ears
```

Device output to the Nabaztag driver can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send…* button. Set something like following, then click the *Send* button:

```
Event Topic       uk/ac/stir/cs/accent/device_out
arg1              move          (message type)
arg2              nabaztag      (entity name)
arg3              both_ears     (entity instance)
arg5              forward       (parameter values)

Event Topic       uk/ac/stir/cs/accent/device_out
arg1              show          (message type)
arg2              nabaztag      (entity name)
arg3              nose          (entity instance)
arg5              blue          (parameter values)
```

Speech output to the Nabaztag driver can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send…* button. Note that the WAV file provided *will be deleted.* Set something like following, then click the *Send* button:

```
Event Topic       uk/ac/stir/cs/accent/speech_out
recipient         nabaztag
mesage            C:/Temp/002185ba6790.wav
```

3.4.17 Ontology Server

The OntologyServer bundle (POPPET) will also run as a Java application. The ontology server starts an RMI (Remote Method Invocation) registry instance on the same system. In principle the ontology server can be run on a remote system. In practice, a firewall and RMI security can get in the way. At the least, the firewall of the remote system must allow incoming connections on port 1099. A security manager and security policy could also be needed on the remote ontology server, though even these can lead to access issues. For these reasons, it is recommended to run the ontology server on the local host.

The ontologies themselves can reside on a remote system or on the local host. For example, they might be deployed in *Tomcat/webapps/schemas*. In this case, the properties file and **only** the Owl imports (*owl:imports*) in the OWL files should refer to *localhost:8080/schemas*. Alternatively, if AccentSchemas is in use then the files should refer to *localhost:8081/schemas.*

Note that the Ontology Server needs to be built as an OSGi bundle (for use in Knopflerfish), but also as a JAR file (for use from the command line) using the Ant build file provided. If the Poppet JAR file is updated, it needs to replace the version currently in the Policy Wizard *WEB-INF/lib* directory. The Unix scripts *poppet-start* and *poppet-stop* are provided in *accent/bin* for command line use. See [1] for more detailed information about the ontology server.

The ontology server supports an ontology service defined by the property file *OntologyServer.properties*, e.g.:

```
# Base URL for OWL ontologies ("http://" prefix assumed)

ontology.base                   www.cs.stir.ac.uk/schemas
# ontology.base                 localhost:8080/schemas
# ontology.base                 localhost:8081/schemas

# Comma-separated list of domains to support (currently call_control, home_care
# and sensor_network). Spaces around commas are ignored:

ontology.domains                home_care.

# Path to where the "rmiregstry" command is located (default assumes it can be
# found on the normal command path):

# rmi.path                      C:/Cygwin/usr/local/jre8.77/bin
```

3.4.18 Plugwise Driver

The PlugwiseDriver bundle was written using public information about the Plugwise protocol. This information is incomplete and conjectural as no official specification exists of the protocol. Although the bundle works satisfactorily, there are some uncertainties as to its operation. The bundle is configured by the property file *PlugwiseDriver.properties*, e.g.:

```
# The port should be the serial port where the Plugwise receiver can be found
# (appears in Windows Device Manager under Ports as "USB Serial Port"):

plugwise.port                   COM5

# The owning entity on whose behalf events will be triggered (user@domain):

plugwise.entity                 admin@cs.stir.ac.uk

# The number of attempts allowed at sending a message (increase for a large or
# noisy network):

plugwise.retry.limit            3

# The first part of all Plugwise module addresses:

plugwise.address.start          000D6F0000

# The interval (minutes) between polls for recent energy consumption. This could
# be as frequently as required since communication errors may result in energy
# readings being lost. The result, however, would be repeated triggers for the
# same energy reading. The normal setting would, however, be for 60 minutes:

plugwise.energy.interval  60

# The interval (minutes) between polls for instantaneous power consumption:

plugwise.power.interval         10

# Plugwise devices support "off" and "on" actions. They can also be polled to
# create input messages "energy" (value in watt-hours) and "power" (value in
# watts). After current power consumption has been received for all Circles, the
# total power is provided in an input message with no entity name or instance.
# Similarly, energy is provided for individual Circles as well as for all
# devices.

# The following mapping relates Circle addresses to entity name/instance in a
# policy trigger or action. The Circle addresses can be in upper or lower case,
# but the entity data must match policies in respect of case. One Circle address
# must be followed by '+' to indicate it is the Circle+. Spaces around commas in
# the entity data are ignored.
#
#   module: Circle address (followed by '+' for Circle+)
#   policy: entity name, entity instance
# 72AE95                 stick

769F17                   kettle,kitchen
76A75A                   fridge,kitchen
76B60E                   phone,lounge
76B960+                  light,lounge
76AEB5                   microwave,kitchen
```

Output to a Plugwise device from the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send*... button. Set something like following, then click the *Send* button:

```
Event Topic       uk/ac/stir/cs/accent/device_out
arg1              on            (message type)
arg2              light         (entity name)
arg3              lounge        (entity instance)
```

3.4.19 Policy Server

PolicyServer can run as a bundle or as a Java application. If OntologyServer or TupleServer is restarted while the policy server is running, this can cause bizarre effects (e.g. the policy server upload port is not properly closed). The bundle normally uses the working directory *PolicyServer* located in the ACCENT properties directory. This working directory is created automatically if needed and is typically used for a log file.

The policy server is configured by file *PolicyServer.properties*. The standard settings are for trigger/action communication, policy upload/download, email, database access, tuple space access, and event handling:

```
# Policy Server properties when running on the local machine

# Database server name (e.g. "localhost"), remote access port number (e.g. 3306)

database.server         localhost
database.port           3306

# Accent database name (e.g. "accent") , username for accessing this
# (e.g. "accent"), password for accessing this, terminology mapping table name
# (e.g. "terminology_mapping")

database.name           accent
database.username       accent
database.password       ------
database.table          terminology_mapping

# Policy event handler (e.g. "EventAdmin" for plain OSGi, "MessageBroker" for
# the Match project, or "ContextServer")

event.provider          EventAdmin
# event.provider        MessageBroker
# event.provider        ContextServer

# Application domain and administrator email for this

application.domain      home_care
application.owner       admin@cs.stir.ac.uk

# SMTP server hostname, port number (e.g. "587"), email account user and
# password, sender email address, subject for email messages from the system.
# Only plain authentication is supported.

mail.server               smtp.acme.com
mail.port                 587
mail.user                 ken
mail.password             shibboleth
mail.sender               ken@acne.com
mail.subject              Policy System Message

# Prefix of system policies (instantiated prototypes) and system variables
# (e.g. "!"), prefix of prototype parameters (e.g. "$"), prefix for variables
# (e.g. ":", which must be escaped as "\:")
```

```
parameter.prefix        $
system.prefix           !
variable.prefix         \:

# Port used for sending events to the policy server (e.g. 9998) and port used
# for uploading/querying policies (e.g. 9999)

policy.message.port     9998
policy.upload.port      9999

# Directory (relative to policy server root) for logging

policy.log.directory    PolicyServer

# Name of the ontology server host (e.g. "localhost")

poppet.host             localhost

# Hex flags to turn on debugging (0000 typically, 0400 to allow wizard policy
# checking, 0404 to add triggered policies, 06CD to add goal handling,
# 07FF for everything):
#   0000  report nothing
#   0001  report prototype contributions to goals
#   0002  report triggering status for policies
#   0004  report triggered policies
#   0008  report dynamic analysis summary
#   0010  report goal formula
#   0020  report identical scores for different prototype combinations
#   0040  report prototype indexes and names being considered for goals
#   0080  report optimised policies
#   0100  report defuzzified policies
#   0200  report static analysis summary
#   0400  record activations even if simulated (for wizard Check Policies)

server.debug            06CD

# Number of lines to preserve in a server log (default 2048)

server.lines            2048

# Number of activation/history records to preserve in the server journal
# (default 128)

server.records          128

# Name of the tuple server host (e.g. "localhost"), port number (e.g. "8200")

tuples.server           localhost
tuples.port             8200

# Name of the policy database (e.g. "Policies"), policy username (e.g.
# "accent"), and password

tuples.name             Policies
tuples.username         accent
tuples.password         ------
```

See [2] for more detailed information about the policy server.

3.4.20 Policy Wizard

The PolicyWizard bundle allows easy definition and editing of policies, goals, etc. It is possible to run the policy wizard as a bundle or as a Tomcat web application. The latter requires a Tomcat context file *Tomcat/conf/Catalina/localhost/wizard.xml* such as:

```
<?xml version="1.0" encoding="UTF-8"?>
<Context docBase="C:/Users/kjt/Home/bin/accent/PolicyWizard"
  path="/wizard" reloadable="true"/>
```

The policy wizard is normally run as a bundle in Knopflerfish. This requires the Pax Web bundles mentioned in section 3.4.2. However, note that the Pax Web versions that have been tested are now rather old. Due to a change in Java around version 8.91 the Jasper compiler in Pax Web JSP no longer works. It is necessary either to run Knopflerfish with an earlier Java version (e.g. 8.77) or to run the Policy Wizard from Tomcat rather than through Knopflerfish. Earlier Oracle Java versions can be downloaded from a location such as https://www.oracle.com/java/technologies/javase/javase8-archive-downloads.html, choosing an architecture such as 'Windows x64' (for Microsoft Windows) or 'Linux ARM 32 Hard Float ABI' (for Raspberry Pi).

Normally the policy wizard would be run as a bundle in Knopflerfish using Pax Web. The HTTP-Server and HTTP-Root-Impl bundles need to be stopped before running Pax Web as the latter will install Jetty as a replacement servlet container. The policy wizard runs as a set of JSPs using Pax Web (see section 3.4.2).

If Tomcat is in use then Pax Web must not be simultaneously running in Knopflerfish. For home care, the policy wizard is typically accessed as follows (the trailing '/' is optional with Tomcat but required for Pax Web):

```
http://localhost:8080/wizard/home_care/
```

If Tomcat is in use but the bundle form of the Policy Wizard is preferred, Pax Web needs to run on a different port. In a Knopflerfish configuration file (e.g. *fwdir-accent/fwprops.xargs*), this might be done by adding:

```
-Forg.osgi.service.http.port=8081
```

OntologyServer, PolicyServer and TupleServer must be started before PolicyWizard is started. (If any of these is restarted with the policy wizard is running, it will be necessary to restart from the policy wizard login page.).

Note that the Policy Wizard needs to be built as a WAR file (Web Archive) for use in Knopflerfish) and also as a webapp (for use in Tomcat) using the *build* script in the top-level Policy Wizard directory. See [4] for more detailed information about the policy wizard.

The policy wizard always has an *admin* user who can create other users. The email address for one of these must be the same as that provided to various communications drivers (e.g. admin@house.stir.net).

When policies are formulated, their triggers and actions must match the mappings in various communications drivers and PolicyAction. Sample triggers are as follows:

```
when told of unoccupied by bed

when told of movement in lounge
```

Sample actions are as follows:

```
do perform dim of lighting in bathroom with value 20

do perform on of heating in kitchen

do perform pause of CD in lounge
```

Although the policy wizard normally runs as a bundle, it is configured outside OSGi. A WAR file, with OSGi bundle manifest, is created by running the following command in the policy wizard root directory (e.g. after recompiling the code or changing property files):

```
jar cfm bin/PolicyWizard-N.N.0.war META-INF/MANIFEST.MF call_control home_care
  sensor_network WEB-INF
```

The location of the property files depends on whether the wizard is running as a bundle (system property *uk.ac.stir.cs.accent* is defined) or as a normal webapp (this property is not defined). In the following, *root* might be *C:/usr/local/knopflerfish/accent*, *domain* might be *home_care*, and *language* might be *en-GB*.

- Bundle: The database property file is external to the wizard; the mapping and wizard property files are bundled with the wizard and are therefore internal:
  ```
  root/PolicyWizard.domain.database.properties
  PolicyWizard/WEB-INF/lib/domain.mapping.properties
  PolicyWizard/WEB-INF/lib/domain/language/wizard.properties
  ```
- Webapp: The database, mapping and wizard property files are bundled with the wizard and are therefore internal:
  ```
  PolicyWizard/WEB-INF/lib/domain/database.properties
  PolicyWizard/WEB-INF/lib/domain/mapping.properties
  PolicyWizard/WEB-INF/lib/domain/language/wizard.properties
  ```

The file *database.properties* defines interfaces to other servers (policy database, policy server, ontology server), e.g.:

```
# Home care wizard properties when running on local machine

# System administrator email address

admin.email                     kjt@cs.stir.ac.uk
```

```
# Name of the database host (e.g. "localhost"), port (e.g. "3306")
# username (e.g. "call_control"), password, name of database (e.g.
# "call_control")

users.host                      localhost
users.database                  home_care
users.password                  ------
users.port                      3306
users.table                     home_care

# Name of the policy server host (e.g. "localhost") and upload port number
# (e.g. "9999")

policy.host                     localhost
policy.message.port             9998
policy.upload.port              9999

# Name of the ontology server host (e.g. "localhost") and ontology name
# (e.g. "home_care")

poppet.host                     localhost
poppet.ontology.name            home_care

# URI prefixes for generic, wizard and home care ontologies (note: append `#' to
# URIs). These are not the URLs for the actual files, which are defined by
# Ontology Server.

ontology.policy.generic         http://www.cs.stir.ac.uk/schemas/genpol.owl#
ontology.policy.wizard          http://www.cs.stir.ac.uk/schemas/wizpol.owl#
ontology.policy.domain          http://www.cs.stir.ac.uk/schemas/home_care.owl#

# Prefix of system policies (instantiated prototypes) and system variables

system.prefix                    !

# Hex flags to turn on debugging (0000 typically, 0001 for everything):
# 0000 (nothing), 0001 (show policy tree), 0002 (show system variables -
# '!' prefix and ontology variables - '*' prefix)

wizard.debug                     0000

# Device actions and triggers

device.actions                  back,cd,lounge/.../volume_up,tv,lounge

device.triggers                 active,flush,toilet/.../shut,window,lounge
```

The device action and trigger properties are currently used only for the home care domain. These are triples separated by '/'. The triples themselves are comma-separated and have the form *message_type,entity_name,entity_instance*. Although these properties can be manually defined, they are normally created automatically by the ConfigurationSetup bundle (see section 3.4.8).

The file *mapping.properties* defines the mapping from policy language names to policy wizard names, e.g. (in part):

```
# Mapping from policy language names to natural language names

# triggers

device_in                       policy.device.in
device_in_raw                   policy.device.in.raw

#conditions

entity_name                     policy.entity.name
...

# actions
```

```
device_out                      policy.device.out
device_out_raw                  policy.device.out.raw

# operators

and                             operator.and
...

ge_epoch                        operator.ge.epoch
...

# Generic conditions

date                            policy.date
day                             policy.day
time                            policy.time

# preferences

must                            policy.must
...
nothing                         policy.nothing
availablility                   policy.status.availability
presence                        policy.status.presence
availablility_raw               policy.status.availability.raw
presence_raw                    policy.status.presence.raw

# Generic policy triggers

timer_expiry                    policy.timer.expiry
timer_expiry_raw                policy.timer.expiry.raw

# Generic policy actions

log_event                        policy.log.event
...
log_event_raw                    policy.log.event.raw
...
apply_default                    resolution.apply.default.action
...
preference0                      resolution.preference0.condition
variable0                        resolution.variable0.condition
...
locale.de-DE                     language.de.de
...
stage.0                          policy.novice
...
```

The file *wizard.properties* defines the mapping from policy wizard names to natural language, e.g. (in part):

```
# The following are interpreted by the browser and so may use HTML entities for
# special characters

# Generic Interface properties

aspect.applicability          Applicability (label, owner, ...)
...
button.cancel                 Cancel
...
edit.action                    Edit Action
...
error.database                 Cannot read database
...
language.de.de                 German - Germany
...

# Generic Policy User levels/stages
```

```
policy.administrator          administrator
...

# Generic Policy Preferences

policy.must                    must
...

# Generic Wizard Hint Text

hint.action                    Set empty to remove an action
...

# Domain-Specific Wizard Hint Text
#
# e.g. for hints of a category of trigger/condition/action:
# hint.*category_name*.action.category
# hint.*category_name*.condition.category
# hint.*category_name*.trigger.category

hint.configure.action.category e.g. 'perform off at bathroom light' or
                              'perform record at VCR 2 delayed 1:00 with value
                               channel=3,period=0:30'
...

# 'status' variables (profile is a permanent variable, but hint text can be
# specified for the domain)

hint.status.profile           e.g. 'weekend' or 'emergency' (empty implies all
                              policies)
...

# Generic Operators

operator.and                   and
...

# Domain-Specific Operators

operator.ge.epoch              is or is after
...

# Generic Policy Properties

policy.address                 address
...

# Domain-Specific Policy Properties

# Triggers

policy.device.in               told of
policy.device.in.raw           device_in(type,ent,inst,period,pars)
policy.status.availability.raw availability
policy.status.presence.raw     presence
...

# Conditions

policy.entity.instance        entity instance
...

# Actions

policy.device.out             perform
policy.device.out.raw         device_out(type,ent,inst,period,pars)
```

```
# Miscellaneous, e.g. descriptive elements such units of time, quantity, etc.

policy.Kbps                    Kbps
...

# Status Variables

policy.status.availability    availability
policy.status.presence        presence

# Domain-Specific Trigger Categories and Argument Labels
#
# e.g. policy.*category_name*.trigger.category     *value*
# e.g. policy.*category_name*.trigger.arg*number*  *value*

policy.configure.trigger.category    event
...

# Domain-Specific Condition Categories
#
# e.g. policy.*category_name*.condition.category   *value*

policy.epoch.condition.category      time
...

# Domain-Specific Action Categories and parameter arg labels
#
# e.g. policy.*category_name*.action.category      *value*
# e.g. policy.*category_name*.action.arg*number*   *value*

policy.configure.action.category     perform
...
policy.send.action.category          send
...
policy.timer.trigger.arg1            called
...
policy.update.action.category  update

# Resolution Conditions (generic)

resolution.POP.condition.category    parameter/parameter comparison
...
resolution.preference0.condition     preference0
resolution.variable0.condition       variable0
...

# Resolution Actions (generic)

resolution.apply.default.action             apply default resolution
...
resolution.generic_res_action.category      generic resolution

# Resolution Action (domain-specific)

## The following are interpreted by JavaScript and so cannot use HTML; escape
## a "'" character with "\\"

# Generic properties

error.action.arg.empty        Parameter field(s) for the selected action cannot
                              be empty and must not begin with "?"
...

# Domain-specific properties

error.address                  Define address in "person@domain", "sms:number" or
                              ":variable" format
...
```

The policy wizard can record audio clips using an applet. However, applets are unlikely to be supported in recent browsers so it may be necessary to use an older browser such as Internet Explorer 11. The JAR for recording audio clips is also self-signed rather than using a proper certificate.

3.4.21 RFID Driver

The ACS ACR122U installation disc and web site (*www.acs.com.hk*) provide drivers. Barcode readings result in input events of the form *device_in(reading,rfid,tag,,description)*. The property file *RFIDDriver.properties* defines the driver configuration, e.g.:

```
# The owning entity on whose behalf events will be triggered (user@domain):

rfid.entity admin@cs.stir.ac.uk

# The mapping translates each RFID tag UID (Unique Identifier) into a string
# reported when the tag/card is read. If the identifier is not found here, the
# literal value is reported. The format of entries is:
#
#   key:    tag/card UID as hex with upper-case letters
#   value:  item description (escape special characters, e.g. "\'")

# Example identifiers (four bytes for a PICC, first four bytes for an ISO
# 14443 A card) are as follows:
#
#   Mifare 1K Card: 8E6DE91F
#
#   Mifare Ultralight Label Rectangular: 04582CA9 (+ E42580 if read in full)
#
#   Mifare Ultralight Label Round: 046ECE82 (+ F32180 if read in full)

DED2E81F           Ask my daughter to call
9E0C1D17           Ask my son to call
CEB2E81F           Cancel milk for one week
4EB41A17           Tell my doctor I am ill
04582CA9E42580     Record \'East Enders\' today
046ECE82F32180     Wake me in one hour
```

The properties file allows zero or more card/tag UIDs (Unique Identifiers) to be mapped to the corresponding descriptions. This can be used by associating particular cards/tags with particular functions. If an identifier is not found in the properties file, it is reported in literal hexadecimal form (which may still be useful in a policy).

Input from an RFID card/tag to the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send…* button. Set something like following, then click the *Send* button:

```
Event Topic       uk/ac/stir/cs/accent/device_in
user              admin@house.stir.net
arg1              reading (message type)
arg2              rfid (entity name)
arg3              tag (entity instance)
arg5              description or 4-byte hexadecimal identifier (parameter values)
```

3.4.22 RFXCOM Driver

The RFXCOMDriver bundle supports a radio receiver for Oregon Scientific and Visonic devices. It is configured by the property file *RFXCOMDriver.properties*, e.g.:

```
# The port should be the serial port where the RFCOM receiver can be found
# (appears in Windows Device Manager under Ports as "USB Serial Port"):

rfxcom.port COM3

# The owning entity on whose behalf events will be triggered (user@domain):

rfxcom.entity      admin@cs.stir.ac.uk

# The mapping translates each sensor signal to trigger parameters (which can be
# omitted from the right). The sensor data can be in upper or lower case, but
# the trigger data must match policies in respect of case. In the key, no spaces
# are allowed and "=" must be escaped as "\=".
#
#   key:    sensor id,sensor code
#   value:  message type,entity name,entity instance,parameter values

# If the signal from a sensor is repeated with the same parameters, it is
# ignored and no event is generated.

# Oregon Scientific temperature-humidity sensors are supported (type BTHR918,
# THGR228, THGR918). The sensor id is the device type (0X5A6D, 0X1A2D, 0X1A3D
# respectively). The sensor code is the channel number in the top quartet
# (0 = 0X0, 1 = 0X1, 2 = 0X2, 3 = 0X4), and the device function in the bottom
# quartet (0X0 = temperature, 0X1 = humidity). For example, "1A2D,01" is a
# THGR228 humidity reading. The sensor reading (temperature, humidity) is
# automatically set in the parameter values ("arg5"). Barometric pressure from
# a BTHR918 is ignored, as are signals from other types of sensors.

# All Visonic sensors are supported. The sensor id is a unique address that must
# be learned separately. For devices that send two signals, sensor code
# 0X04 = active (e.g. open, smoke/gas, wet) and 0X84 = inactive (e.g. closed,
# clear, dry). For devices that send one signal, sensor code 0X0C = active
# (e.g. movement, alarm). No parameter values ("arg5") are set.

# front door switch:

4891AE,00   battery,door,front
4891AE,04   open,door,front
4891AE,84   shut,door,front

# kitchen movement sensor

82DDCB,00   battery,movement,kitchen
82DDCB,0C   active,movement,kitchen
82DDCB,8C   clear,movement,kitchen

# kitchen smoke detector (seems to send 84 rather than 8C for clear)

168059,00   battery,smoke,kitchen
168059,0C   active,smoke,kitchen
168059,84   clear,smoke,kitchen
168059,8C   clear,smoke,kitchen

# lounge temperature-humidity sensor (type THGR228, channel 1):

1A2D,00            battery,temperature,interior
1A2D,10            reading,temperature,interior
1A2D,11            reading,humidity,interior

# outdoor temperature-humidity sensor (type THGR810, channel 1):

FA28,00            battery,temperature,exterior
FA28,10            reading,temperature,exterior
FA28,11            reading,humidity,exterior

# pendant alarm

43B0DE,00   battery,pendant
43B0DE,0C   active,pendant
43B0DE,8C   clear,pendant

# toilet flush sensor

9B63A9,00   battery,flush,toilet
9B63A9,04   active,flush,toilet
9B63A9,84   clear,flush,toilet

# wrist alarm
```

```
8E64DE,00   battery,wrist
8E64DE,0C   active,wrist
8E64DE,8C   clear,wrist
```

Input from a wireless device to the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send*... button. Set something like following, then click the *Send* button:

```
Event Topic       uk/ac/stir/cs/accent/device_in
user              admin@house.stir.net
arg1              unoccupied (message type)
arg2              bed (entity name)
arg3              main (entity instance)
```

3.4.23 SMS Driver

The SMSDriver bundle uses a GPRS modem and is configured by the property file *SMSDriver.properties*, e.g.:

```
# The port should be the serial port where the GPRS modem can be found
# (appears in Windows Device Manager under Modems as "GPRS609 USB Modem";
# to find the port number, go to "Network Connections", "GPRS609
# USB", "Properties")

# The port should be the serial port where the GPRS modem can be found:

sms.port          COM9

# The bit rate for the serial port (e.g. 115200, 57600, 38400, 19200, 9600):

sms.rate          115200

# The owning entity on whose behalf events for incoming messages will be
# triggered (user@domain):

sms.entity        admin@house.stir.net

# The international prefix for the locale (e.g. 44 for UK):

sms.international  44

# The national prefix for the locale (e.g. 0 for UK):

sms.national      0

# The following mapping translates policy user addresses into mobile phone
# numbers; the reverse mapping is automatically defined. The corresponding user is
# then used as the caller in the policy trigger.
#
# If the calling phone number does not match any entry, it will be provided
# literally as the caller.
#
# A user address has the form 'user@domain'; case is significant, and spaces are
# not allowed. A mobile phone number is a list of digits, but with the following
# variants:
#
#  ' '            white space is allowed but removed
#  '-'            a minus is allowed but removed
#
# If the inbound or outbound phone number starts with "+", it will be
# converted from international to national form prior to lookup in this table.

admin@house.stir.net      07593-246-801

kjt@cs.stir.ac.uk         07811-123-456
```

When an inbound message arrives, it results in a *receive_message* trigger for the policy server with the following environment parameters:

```
user              as defined by sms.entity
call_type         "SMS"
topic             "Text message"
```

```
caller            policy user address (originating phone number if not defined)
call_content      the text message itself
```

An outbound message is sent with the action a *send_message(recipient,message)* from the policy server. The recipient can be specified as a national phone number (e.g. 07811-123-456), an international one (e.g. +44-7811-123-456), or as a user address (e.g. kjt@cs.stir.ac.uk). The latter will be converted into a national phone number using the property definitions.

A request to output an SMS message from the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send...* button. Set something like following, then click the *Send* button:

```
Event Topic       uk/ac/stir/cs/accent/send_message
recipient         07811-123-456
message           Time for lunch
```

'+', '-' and white space are removed from the phone number as given. An international phone number such as '+44-7811-123-456' may also be used.

3.4.24 Soap Proxy

The SOAPProxy bundle cooperates with ActiveBPEL (*https://sourceforge.net/projects/activebpel502*) to map between OSGi events and web service calls. The bundle maps events as defined by the property file *SoapProxy.properties*, e.g.:

```
# The base URL of the BPEL services, "/services/<service_name>" being appended
# to this:

proxy.url                http://localhost:8080/active-bpel

# A comma-separated list of entity names in any case that may appear in
# device_in/out events. If class <Entity>In and/or <Entity>Out exist, it is
# instantiated. The following entity types are currently recognised:
#
#   alert (in)           fall, freezing
#   bed (in)             free, occupied
#   cd (out)             back, fast_forward, fast_reverse, forward, next, off,
#                        on, pause, play, previous, record*, stop,
#                        track_set(digits)
#   chair (in)           free, occupied
#   cooker (out)         off, on
#   door (in)            open, shut
#   door (out)           lock, unlock
#   drier (out)          off, on
#   dvd (out)            back, channel_down, channel_set(digits),
#                        channel_up, drive*, fast_forward, fast_reverse, forward,
#                        mute*, next, off, on, pause, play, previous, record*,
#                        stop, volume_down, volume_up
#   dvb (out)            channel_down, channel_set(digits), channel_up,
#                        mute, off, on, volume_down, volume_up
#                        volume_up
#   fall (in)            active
#   fan (out)            off, on
#   flood (in)           clear, active
#   gas (in)             clear, active
#   heating (out)        off, on
#   humidity (in)        reading(percentage)
#   light (out)          dim(percentage), off, on
#   mat (in)             active
#   medicine (in)        active
#   message (in, out)    receive(sender,subject,message),
#                        send(sender,subject,message)
#   movement (in)        active
#   pendant (in)         active
#   phone (out)          text
#   pressure (in)        reading(millibars)
#   smoke (in)           clear, active
#   sms (in)             text
#   sms (out)            text
#   temperature (in)     reading(centigrade)
#   tv (out)             channel_down, channel_set(digits), channel_up,
#                         mute, off, on, volume_down, volume_up
#   vcr (out)             back, channel_down, channel_set(digits),
#                         channel_up, fast_forward, fast_reverse, forward, mute*,
#                         next, off, on, pause, play, previous, record, stop,
#                         volume_down, volume_up
#   washer (out)          off, on
#   window (in)           open, shut
#   wrist (in)            active
#
# Device parameters in the above list are shown in parentheses. Asterisked
# actions may not be available on all devices.

proxy.entities            alert, door, fall, heating, light, movement, phone, sms,
                          speech, temperature
```

See [3] for more detailed information about the SOAP proxy. Note that the SOAP Proxy requires a modified version of the Knopflerfish Axis1 package (section 3.4.3). See also the *README* file in *knopflerfish/osgi/jars/axis-osgi*.

3.4.25 Speech Recogniser

The SpeechRecogniser bundle accepts *speech_in* events, with *sender* indicating the sending device and *message* giving the full path to an audio file. Audio can be in most reasonable formats including 8kHz and 16kHz sample rates as well as ADPCM and PCM encoding. The audio is converted into FLAC format using JAVE (https://www.sauronsoftware.it/projects/jave) which in turn is a wrapper for FFmpeg (http://www.ffmpeg.org).

Audio is then sent to the Google Speech Service (Version 2) for recognition. The SpeechRecogniser interface to this service is based on ideas from JARVIS (https://github.com/The-Shadow/java-speech-api). The result is a *receive_message* message with *sender* as the sending device and *message* as the recognised text. By virtue of the Google Speech service, recognition is possible in multiple languages. However this means that, unlike most other bundles, the speech recogniser requires the ACCENT system to have an Internet connection.

It appears that Google speech API keys may no longer be available, requiring use of a Google Cloud API that is not currently supported by this bundle.

The bundle uses the working directory *SpeechRecogniser* located in the ACCENT properties directory. This working directory is created automatically if needed and is used for temporary speech files. The speech recogniser is configured by the property file *SpeechRecogniser.properties*, e.g.:

```
# The owning entity on whose behalf events will be triggered (user@domain):

speech.entity             admin@cs.stir.ac.uk

# Speech API key (see http://www.chromium.org/developers/how-tos/api-keys)

speech.key                -------------------

# Speaker language (<language>-<COUNTRY>, default en-GB)

speech.locale             en-GB
```

Input to the speech recogniser can be simulated through OSGi. First record some speech as a WAV file, e.g. using an audio application like Audacity or by using the Nabaztag. Choose the *Events* tab in Knopflerfish and click the *Send...* button. Set something like following, then click the *Send* button but note that the given audio file *will be deleted*:

```
Event Topic       uk/ac/stir/cs/accent/speech_in
sender            nabaztag
mesage            C:/knopflerfish/accent/002185ba6790.wav
```

3.4.26 Tunstall Driver

The TunstallDriver bundle is configured by the property file *TunstallDriver.properties*, e.g.:

```
# The port should be the serial port where the Tunstall Tapit receiver can be
# found (appears in Windows Device Manager under Ports as "USB Serial Port"):

tunstall.port      COM7

# The owning entity on whose behalf events will be triggered (user@domain):
```

```
tunstall.entity    admin@cs.stir.ac.uk

# The mapping translates each sensor signal to trigger parameters (which can be
# omitted from the right). The sensor id is a location code assigned by the PC
# Connect application to a sensor. Policy parameter values are reserved for
# future use. Sensor data is case-sensitive, and the trigger data must match
# policies in respect of case. Spaces are allowed round commas, and "=" must
# be escaped as "\=".
#
#   key:    sensor id,sensor code
#   value:  message type,entity name,entity instance,parameter values

# If the signal from a sensor is repeated with the same parameters, it is
# ignored and no event is generated.

# The Tunstall sensors supported are Bed/Chair Occupancy (strip attached to
# IP2), Door Switch (activated by magnet), Medication Dispenser (the Addoz unit
# signals only missed  medication), Personal Trigger (pendant and wrist alarms)
# and PIR (Standard).

# base unit buttons:

00,HA click,lifeline,red
00,Ha click,lifeline,green
00,Hc click,lifeline,yellow

# wrist alarms (id 126416 = pendant/resident1, id 83055 = wrist/resident2):

01,AA active,pendant,resident1

02,AA active,wrist,resident2

# bed sensor (id 34845 = bed/lounge):

21,AZ occupied,bed,lounge
21,BA free,bed,lounge

# door sensors (id 37805 = door/front):

80,AQ open,door,front
80,AR shut,door,front

# movement sensors (id 118483 = movement/kitchen):

41,BH active,movement,kitchen

# medication dispenser (Addoz unit signals only missed medication)

02,CZ missed,medication
02,JH taken,medication
```

Input from a Tunstall device to the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send...* button. Set something like following, then click the *Send* button:

```
Event Topic       uk/ac/stir/cs/accent/device_in
user              admin@house.stir.net
arg1              occupied (message type)
arg2              bed (entity name)
arg3              lounge (entity instance)
```

3.4.27 Tuple Server

The TupleServer supports the policy store. This uses IBM TSpaces that this is now an inactive project. It listens on port 8200 on the machine where it is started. Port 8201 is typically configured to support a web interface to check tuple space contents. It starts an XML database defined by the property file *TupleServer.properties*, e.g. the following that is adapted from the TSpaces sample configuration file:

```
# The [Server] section contains general specifications for the TSServer.
```

```
[Server]

# The port that it listens to for requests.

Port =                         8200

# Default Space options

# If tuple results should be returned in FIFO order

ResultOrderFIFO =              false

# The pathname of the directory used for checkpointing

CheckpointDir =                C:/usr/local/tspaces/ts-checkpoint

# The interval between dumping the checkpoint data (minutes)

CheckpointInterval =           10.0

# The number of updates before checkpoint is requested (-1 to disable)

checkpointWriteThreshold =     -1

# The interval beween checking for deadlocked threads (seconds)

DeadLockInterval =             15

# The interval between scans for expired tuples (minutes)

ExpireInterval =               15

# The [HTTPServer] section contains parameters for the internal HTTP server

[HTTPServer]

HTTPServerSupport =            true
HttpPort =                     8201

# Turn off the Web Admin support (only use this for development)

HTTPAdminSupport =             false

# The directory where downloadable class files are kept

ClassesDirectory =             ./

# The [FileStore] section contains parameters for the internal FileStore

[FileStore]

# The directory where files are stored

CacheDir =                     C:/usr/local/tspaces/ts-cache

# The [AccessControl] section contains parameters needed for AccessControl

[AccessControl]

# If false, no access checking will be done

ACVerifierClass =              com.ibm.tspaces.security.AccessControlVerifier

CheckPermissions =             true

# The set of Users and Groups.
```

```
AdminUser =                     root
AdminPassword =                 ------
AdminGroup =                    AdminGroup

# The list of valid groups

TopGroup =                      Users

[Group-Users]

accent
root

# Subgroups of "Users"

Group AdminGroup

 [Group-AdminGroup]

root

# The [DefaultACL] section sets up the Default Access Control List

[DefaultACL]

Accent                          Read Write
Root                            Read Write Admin
Users                           Read

# The [CreateACL] section sets up the Access Control List that is used
# to control who can create new Spaces.

[CreateACL]

Accent                          Create
root                            Create
```

See [2] for more detailed information about how the policy store is used.

3.4.28 TuxDroid Driver

The TuxDroidDriver bundle is configured by the property file TuxDroid.properties, e.g.:

```
# The TuxDroid supports a variety of different policy triggers and actions as
# follows. Alternatives are separated by '|'. Internal trigger or action
# parameters are the same as policy parameters.

# The owning entity on whose behalf events will be triggered (user@domain):

tuxdroid.entity                              admin@cs.stir.ac.uk

# Name of the TuxDroid audio device:

tuxdroid.audio.device                        Speakers (TuxDroid-Audio)

# The interval between reporting average light level (minutes):

tuxdroid.light.interval   5

### Input Triggers ###

# Input events arrive with the message type and entity instance shown below, and
# the entity name fixed at "tuxdroid". An example input might be
# "device_in(click,tuxdroid,head)".

# Battery low warning:

battery                                      battery
```

```
# Button click on head or wings:

click,head                                     click,head
click,wing,left|right                          click,wing

# Light reading:

reading,light                                  reading,light

### Output Actions ###

# Output actions are sent with the message type and entity instance shown below,
# and the entity name fixed at "tuxdroid". In some cases a third parameter value
# is supplied. An example output might be
# "device_out(set,tuxdroid,wings,,flp_slow)".

# Lights (flash or wink switches light on then off, off/on leaves the light off
# or on until told to change this):

off|on|flash|wink,eyes,left|right|both         off|on|flash|wink,eyes

# Mouth (speak = mouth opens and closes repeatedly):

open|shut|speak,beak                           open|shut|speak,beak

# Eyes:

open|shut|blink,eyes                           open|shut|blink,eyes

# Reset (wings down, eyes open, facing forward, beak closed, lights off):

reset                                  reset

# Body (roughly left/right = 180 degrees, spin left/right = 360 degrees):

rotate,body,left|right|spin_left|spin_right    rotate,body

# Wings:

set,wings,up|down|flap_slow|flap_fast          set,wings
```

Example policy server inputs might be:

```
Event Topic       uk/ac/stir/cs/accent/device_in
arg1              click  (message type)
arg2              tuxdroid      (entity name)
arg3              head          (entity instance)

Event Topic       uk/ac/stir/cs/accent/device_in
arg1              reading       (message type)
arg2              tuxdroid      (entity name)
arg3              light         (entity instance)
arg5              9.5           (parameter values)
```

Output to a TuxDroid from the policy server can be simulated through OSGi. Choose the *Events* tab in Knopflerfish and click the *Send*... button. Set something like following, then click the *Send* button:

```
  Event Topic      uk/ac/stir/cs/accent/device_out
  arg1             blink         (message type)
  arg2             tuxdroid      (entity name)
  arg3             eyes          (entity instance)

  Event Topic      uk/ac/stir/cs/accent/device_out
  arg1             set           (message type)
  arg2             tuxdroid      (entity name)
  arg3             wings         (entity instance)
  arg5             flap_slow     (parameter values)
```

3.4.29 X10 Driver

The X10Driver bundle is adapted from code by Michael Wilson. It uses the Java X10 package from Jesse Petersen and others (http://www.agaveblue.org/projects/x10). The bundle is configured by the property file *X10Driver.properties*, e.g.:

```
# The port should be the serial port where the X10 computer module can be found
# (appears in Windows Device Manager under Ports as "Prolific USB-to-Serial
# Comm Port"):

x10.port    COM6

# The following mapping describes a comma-separated list of mappings from
# policy actions to protocol commands. The key data must match policies in
# respect of case, but the value data can be in either case. Spaces can be used
# after commands, and special characters such as "=" must be escaped as "\=".
#
#   key:    message,entity,instance,parameters
#   value:  command,address,parameters
#
# One or more messages or commands may be given, separated by "|"; the number of
# these in the key and value must be the same. The instance is optional. The
# parameters can be comma-separated and are optional; if a policy action does
# not match the mapping with its specific parameters, a match is tried without
# the parameters.
#
# Parameters then instance may be omitted from the right (e.g.
# "message,entity,instance" and "message,entity" or "command,address" can be
# used).
#
# Mapping entries can be repeated for the same message, entity and instance but
# with different parameters.

# All X10 devices support "off" and "on" actions. Specialised policy actions are
# as follows:
#
#   X10 Light:           dim

# Standard lamp in lounge

off|on|dim,standard_lamp,lounge        off|on|dim,c2

dim,standard_lamp,lounge,very_dim      dim,c2,20
dim,standard_lamp,lounge,dim           dim,c2,30
dim,standard_lamp,lounge,moderate      dim,c2,50
dim,standard_lamp,lounge,bright        dim,c2,70
dim,standard_lamp,lounge,very_bright   dim,c2,85

# Bedside lamp in lounge

off|on|dim,bedside_lamp,lounge         off|on|dim,c3

dim,bedside_lamp,lounge                dim,c3
dim,bedside_lamp,lounge,very_dim       dim,c3,20
dim,bedside_lamp,lounge,dim            dim,c3,30
dim,bedside_lamp,lounge,moderate       dim,c3,50
dim,bedside_lamp,lounge,bright         dim,c3,70
dim,bedside_lamp,lounge,very_bright    dim,c3,85

# Blinds in lounge

open|close|set,blinds,lounge           open|close|set,c1
```

Output to an X10 device from the policy server can be simulated through OSGi. (This requires PolicyAction to be running.) Choose the *Events* tab in Knopflerfish and click the *Send…* button. Set something like following, then click the *Send* button:

```
Event Topic       uk/ac/stir/cs/accent/device_out
```

```
arg1              on            (message type)
arg2              light         (entity name)
arg3              bathroom      (entity instance)

Event Topic       uk/ac/stir/cs/accent/device_out
arg1              dim           (message type)
arg2              light         (entity name)
arg3              bathroom      (entity instance)
arg5              25            (parameter values, here the dim percentage)
```

4 Conclusion

This report has described the architecture, installation and configuration of components in the ACCENT policy system for home care. It has been seen that all ACCENT components are bundles deployed in the Knopflerfish OSGi platform (though several of the key components will also run as applications). Most bundles are configured through property files deployed in a Knopflerfish directory. The components exchange information through the OSGi Event Admin service.

References

[1] Gavin A. Campbell. Overview of Policy-Based Management using POPPET, Technical Report CSM-168, Computing Science and Mathematics, University of Stirling, June 2006.

[2] Stephan Reiff-Marganiec, Kenneth J. Turner, Lynne Blair and Feng Wang. The ACCENT Policy Server, Technical Report CSM-164, Computing Science and Mathematics, University of Stirling, August 2013.

[3] Kenneth J. Turner. Device Services for The Home, in Khalil Drira, Ahmed Hadj Kacem and Mohamed Jmaiel, editors, Proc. 10th Int. Conf. on New Technologies for Distributed Systems, pages 41–48, IEEE Computer Society, Los Alamitos, California, USA, June 2010.

[4] Kenneth J. Turner and Gavin A. Campbell. The ACCENT Policy Wizard, Technical Report CSM-166, Computing Science and Mathematics, University of Stirling, April 2014.

[5] Kenneth J. Turner, Stephan Reiff-Marganiec, Lynne Blair, Gavin A. Campbell and Feng Wang. APPEL: The ACCENT Project Policy Environment/Language, Technical Report CSM-161, Computing Science and Mathematics, University of Stirling, April 2014.